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INSTALLATION RESTORATION PROGRAM
PHASE II - CONFIRMATION
QUANTIFICATION
STAGE 2

VOLUME I

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MACDILL AIR FORCE BASE
FLORIDA

ENGINEERING-SCIENCE

Atlanta, Georgia

JULY 1988

FINAL REPORT FOR PERIOD OF JULY 1986 TO JULY 1988

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PREPARED FOR

HEADQUARTERS TACTICAL AIR COMMAND
COMMAND SURGEON'S OFFICE (HQ TAC/SGPB)
BIOENVIRONMENTAL ENGINEERING DIVISION
LANGLEY AIR FORCE BASE, VIRGINIA 23665-5001

UNITED STATES AIR FORCE
OCCUPATIONAL & ENVIRONMENTAL HEALTH
LABORATORY (USAFOEHL)
BROOKS AIR FORCE BASE, TEXAS 78235-5501

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MACDILL AFB, FLORIDA

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JULY 1988

Prepared By

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57 Executive Park South, Suite 590
Atlanta, Georgia 30329

USAF CONTRACT NO. F33615-84-D-4403
DELIVERY ORDER NO. 0014

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USAF OCCUPATIONAL & ENVIRONMENTAL HEALTH LABORATORY
(USAFOEHL)
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BROOKS AIR FORCE BASE, TEXAS 78235-5501

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An Installation Restoration Program (IRP) Phase II, Stage 2 investigation was conducted at MacDill AFB and Avon Park AFB, Florida, to confirm the presence or absence of contamination at twelve sites. Eight of the twelve sites were previously investigated under Phase II, Stage 1 efforts. Four sites had not previously been investigated under Phase II efforts. A field program was conducted, consisting of geophysical surveys, the drilling and installation of 28 monitoring wells, an aquifer pumping test in the surficial aquifer, and the collection and analysis of groundwater, surface water, and sediment samples. At MacDill AFB, no significant contaminants were found at two of the sites. These sites were recommended for no further action. At three other sites no significant contamination was found but other evidence suggested that additional study should be considered before specific action at these sites is recommended. Significant contamination was found at three sites and these sites were recommended for additional investigation. One site at MacDill AFB was recommended for remedial action. At Avon Park AFB, all three sites showed no significant contamination and were recommended for no further action.

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PREFACE

Engineering-Science (ES) has entered into an agreement with the U.S. Air Force to perform a Phase II, Stage 2 IRP Investigation at MacDill Air Force Base and Avon Park Air Force Range near Tampa, Florida. This investigation was initiated in June 1986 under Agreement F33615-84-D-4403, Delivery Order 0014. The overall objectives of this effort were to define the magnitude, extent, direction, and rate of movement of identified contaminants and to determine the need for remedial actions based on an assessment of risks to human health and the environment.

This investigation was performed by Engineering-Science personnel from the Atlanta, Georgia office. Mark A. Guthrie, P.E., served as Project Manager and Walker J. Duncan, P.G., served as Project Leader and Hydrogeologist. Ernest J. Schroeder, P.E., and Robert S. McLeod, P.E., were Technical Reviewers for the project. Craig L. Sprinkle served as Geochemist and A. Scott Yankey was the Project Geologist and Field Team Leader.

Engineering-Science wishes to acknowledge Diversified Drilling, Inc. of Tampa, Florida, as the drilling and well installation subcontractor. Heidt and Associates of Tampa, Florida, provided surveying services and Savannah Laboratories and Environmental Services, Inc. of Savannah, Georgia and Tallahassee, Florida provided analytical services. Michael Newberry, Captain USAF, and Jeff Mason, 2d LT., USAF, from the MacDill AFB Bioenvironmental Engineering Office, provided support at the base level.

This work was accomplished between July 1986 and January 1988. 1st Lieutenant Dale J. Dietzel, Technical Services Division, USAF Occupational and Environmental Health Laboratory (USAFOEHL) was the Technical Monitor.



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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

INTRODUCTION AND PURPOSE

The Department of Defense (DOD) has developed a program to identify and evaluate sites where contamination may be present on DOD property because of past spills or hazardous waste disposal practices, to control the migration of hazardous contaminants, and to control hazards to health, welfare or the environment that may result from contamination at these sites. This program is called the Installation Restoration Program (IRP). The IRP has four phases:

- o Phase I - Installation Assessment/Records Search
- o Phase II - Confirmation/Quantification,
- o Phase III - Technology Base Development, and
- o Phase IV - Remedial Actions.

Engineering-Science, Inc. (ES) was retained by the United States Air Force (USAF) to conduct the Phase II, Stage 2 IRP investigation at MacDill Air Force Base near Tampa, Florida and the Avon Park Air Force Range, under Contract F33615-84-D-4403, Delivery Order 0014.

The overall objectives of the Phase II effort are to define the magnitude, extent, and direction and rate of movement of identified contaminants, and to determine the need for remedial actions based on an assessment of risks to human health and the environment. To meet these objectives, a series of staged field investigations may be required. Specific objectives of the Stage 2 investigation at MacDill AFB were:

- o to determine the presence or absence of contamination at the past spill and waste-disposal sites identified,
- o to determine the magnitude and extent of contamination and, where possible, the potential for migration of contaminants in the various environmental media,

- o to identify potential environmental consequences and health risks of known contaminants, based on State or Federal standards and guidelines, and
- o to identify any specific requirements for additional monitoring to confirm the magnitude, extent, migration, or identity of contaminants present.

BACKGROUND INFORMATION

MacDill Air Force Base is located in west-central Florida near the city of Tampa (Figure 1). The base occupies approximately 5,600 acres of land at the southern tip of the Interbay Peninsula. It is bordered by Tampa Bay to the west, Hillsborough Bay to the east, and the city of Tampa to the north.

Avon Park Air Force Range (AFR) is located approximately 65 miles east of Tampa in Polk and Highland Counties, Florida. The range is located on approximately 106,000 acres of land, of which 103,500 are unimproved land.

The host unit at MacDill AFB is the 56th Tactical Fighter Wing, which is also responsible for maintaining the Avon Park AFR. This unit is part of the Tactical Air Command and its primary mission is to train pilots in the F-16 Fighting Falcon. The Avon Park AFR is used for training crews in bombing, strafing, and electronic warfare activities. An auxiliary airfield is also maintained at Avon Park (AFR).

IDENTIFICATION OF SITES FOR INVESTIGATION

MacDill AFB and the Avon Park AFR were previously investigated under the IRP Phase I (CH2M HILL, 1981) and Phase II, Stage 1 (WAP, 1984) studies. Site A, Former Fuel Storage Area Adjacent to AGE, was investigated under a IRP Phase IV-A Study (Kirkner, 1986). Based on the results of these studies and Air Force reviews, nine sites at MacDill AFB and three sites at Avon Park AFR were recommended for study under the Phase II, Stage 2 investigation. Table 1 summarizes the past histories and previous investigations for these twelve sites. The nine sites at MacDill AFB are shown on Figure 2 and the three sites at Avon Park AFR are shown on Figure 3.

FIGURE 1

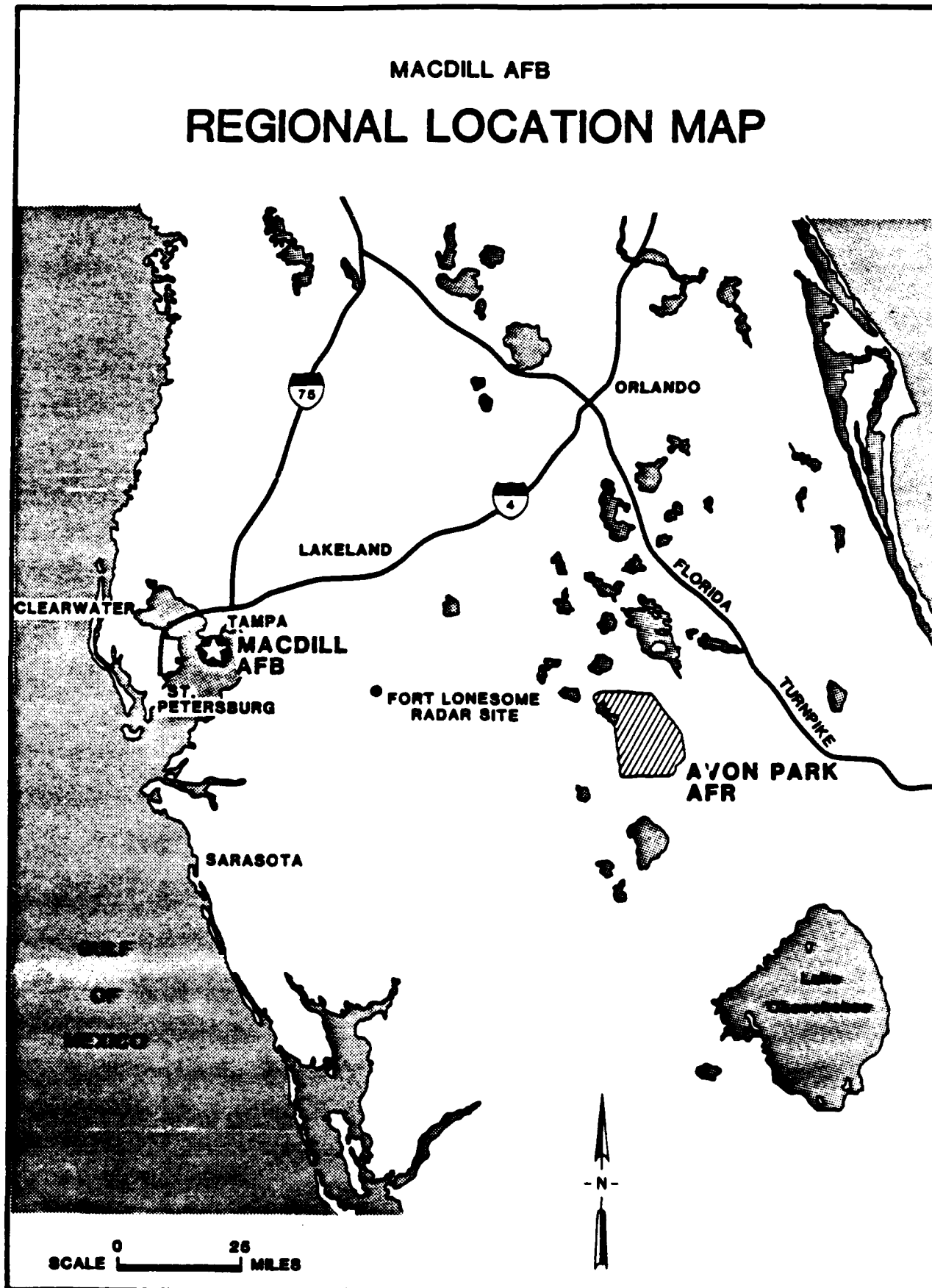
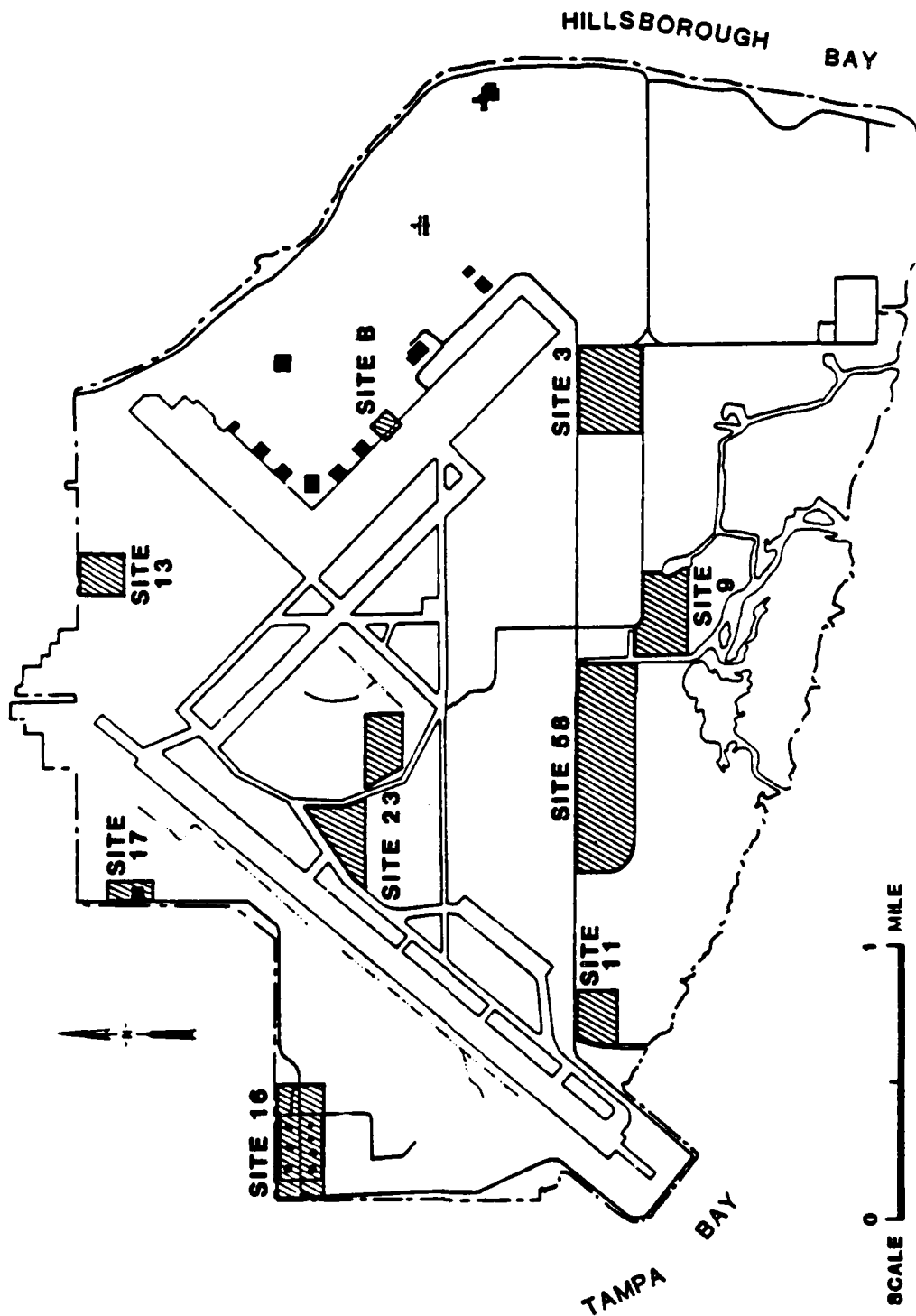


TABLE 1
SUMMARY OF IRP PHASE II, STAGE 2 SITE HISTORIES
AT MACDILL AFB AND AVON PARK AFB

Site No.	Site Name	Period of Use	Suspected Wastes or Materials Stored, Spilled, or Disposed in the Past	Previous IRP Efforts
B	Former Fuel Storage Area No. 2	1950's to 1972	Contaminated fuel and waste solvents.	Not investigated previously
3	Landfill at Dog Kennel	1950 to 1959	General refuse, paint cans, solvents, PCB-containing capacitors.	Phase I Phase II, Stage 1
5-8	Past Landfills	1959 to 1973	General refuse and garbage, and small quantities of waste oil, solvents, paints, thinners, battery casings, pesticides, herbicides, PCB capacitors, adhesives, construction debris, and tires.	Phase I Phase II, Stage 1
9	Recent Landfill	1973 to 1986	General refuse and garbage, and small quantities of waste oil, solvents, paints, thinners, battery casings, pesticides, herbicides, PCB capacitors, adhesives, construction debris, and tires.	Phase I Phase II, Stage 1
11	Chemical Munitions Burial Area	1950 to 1955	Unknown chemicals.	Identified in Phase I
13	Creosote Pit	Prior to 1945	Creosote.	Identified in Phase I
16	Fuel Tank Farm	1952 to present	AVCAs sludge, tetraethyl lead, aviation gasoline, diesel fuel, JP-4, and JP-5.	Phase I Phase II, Stage 1
17	Drum Storage Area	1965 to present	PCB transformers, waste oils, solvents, paints, AVCAs sludge.	Phase I Phase II, Stage 1
23	Fire Training Area	1950's to present	Waste oils, contaminated fuel, solvents.	Phase I Phase II, Stage 1
AP-6	Old Landfill, Avon Park AFB	1950 to 1978	General refuse, garbage, suspected small quantities of unidentified hazardous wastes.	Phase I Phase II, Stage 1
AP-7	Recent Landfill, Avon Park AFB	1978 to 1985	General refuse, garbage, suspected small quantities of unidentified hazardous wastes.	Phase I Phase II, Stage 1
AP-9	Army Test Site, Avon Park AFB	1951 to 1965	Herbicides, dioxin.	Identified in Phase I

FIGURE 2

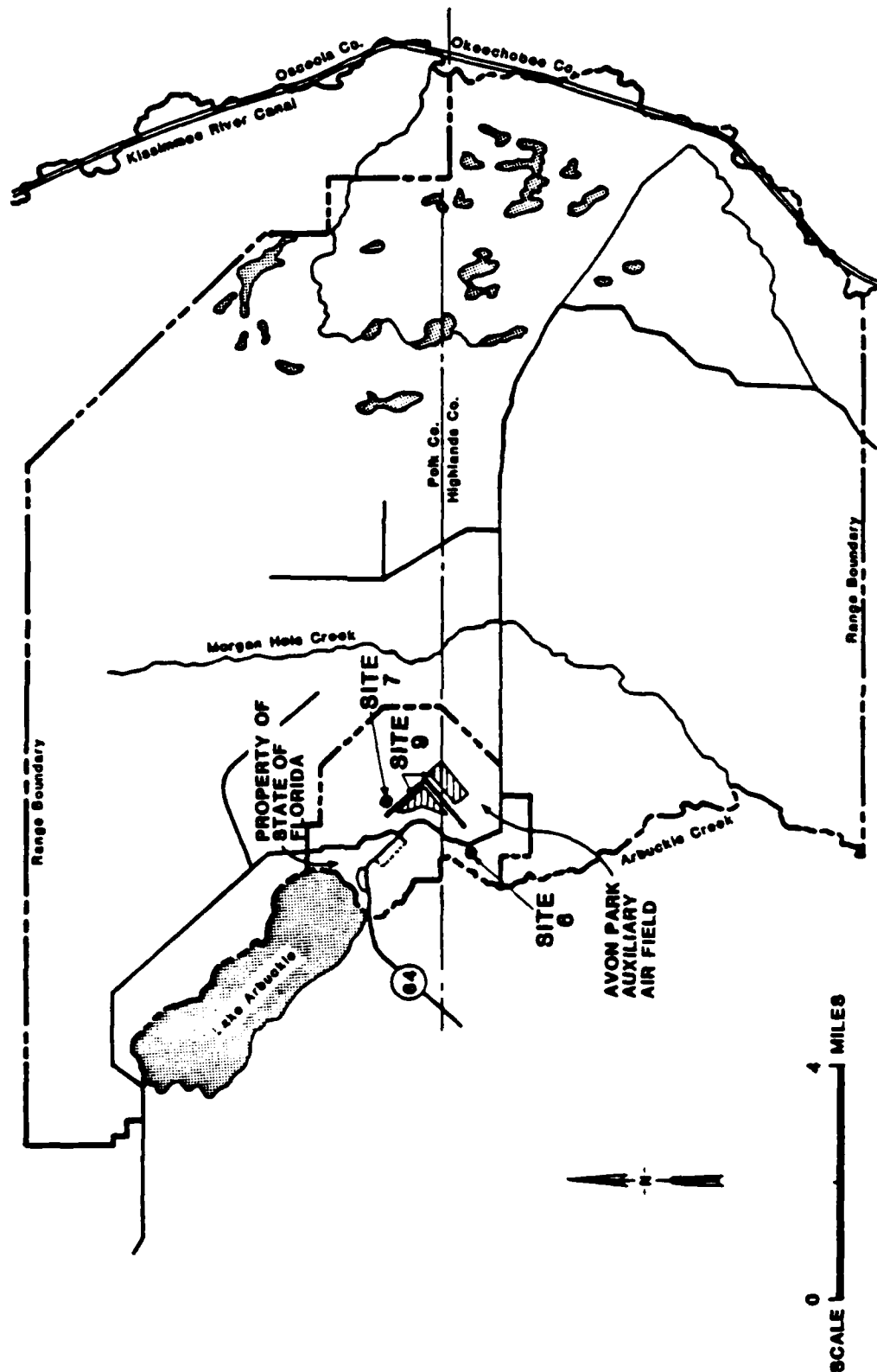
MACDILL AFB LOCATION OF SITES INVESTIGATED UNDER PHASE II, STAGE 2



SOURCE: USGS 7.5 Minute Quadrangles.

FIGURE 3

AVON PARK AFR LOCATION OF SITES INVESTIGATED UNDER PHASE II, STAGE 2



ENVIRONMENTAL SETTING

MacDill AFB is located at the southern tip of the Interbay Peninsula in Hillsborough County, Florida. This area has a humid, subtropical climate that is characterized by long, hot summers and short, mild winters. The climate is moderated by the Gulf of Mexico which is responsible for mild winter temperatures and high relative humidities. The rainy season at MacDill AFB occurs from May through September and the dry season occurs during fall and winter. Annual rainfall averages approximately 44 inches with the lowest rainfall in April and highest rainfall in August. Heavy thunderstorms are common during summer months, accounting for high rainfall averages during the summer season. Average annual evapotranspiration is approximately 39 inches and average annual lake evaporation is approximately 51 inches (Fernald and Patton, 1984).

MacDill AFB is located within the Gulf Coastal Lowlands of the Gulf Coastal Plain Province which is characterized by flat topography with numerous wetlands. The base is also characterized by flat topography, with elevations of 15 feet msl or less. Much of the base is below 5 feet msl and is covered by mangrove swamp.

Surface water hydrology on MacDill AFB is characterized by low, flat areas with low runoff rates and standing water areas (wetlands). Drainage canals, storm drains, and tidal creeks drain the base into Tampa Bay and Hillsborough Bay. Surface water runoff from precipitation is controlled by a stormwater canal system which carries water to tidal creeks or directly to Tampa Bay or Hillsborough Bay. Tidal streams and mangrove swamps cover a large portion of the south base area. Broad Creek and Coon Hammock Creek are the two main outlets in the mangrove area.

Central Florida and MacDill AFB lie within the Atlantic Coastal Plain Geologic Province. The Coastal Plain is characterized by thick unconsolidated to consolidated sediments forming a wedge that thins inland and generally overlies crystalline bedrock. In Central Florida, the Coastal Plain sediments found at the surface are Miocene or younger rocks and consist of clastic sediments and some sandy limestones and dolomites. The surficial deposits at MacDill AFB consist of thin layers of fine, quartzitic sands and clay which overlie the Tampa Limestone.

The Tampa Limestone has an irregular surface of solution cavities and voids and is the upper-most unit of the Floridan Aquifer System in this area.

The regional hydrogeology of the west-central Florida area is characterized as a multilayered aquifer system which includes a surficial aquifer and the confined Floridan Aquifer. Groundwater at MacDill AFB occurs in the shallow, surficial aquifer under unconfined conditions. The surficial aquifer at MacDill AFB consists of fine to very fine sands and clayey sands which are from five to twenty feet thick. The water table in these materials is shallow, often as high as three feet below ground surface. The Upper Floridan Aquifer underlies the surficial aquifer at MacDill AFB. The surficial aquifer and the Floridan Aquifer may be hydraulically connected in some areas beneath MacDill AFB.

The surficial aquifer is not used for water supplies on MacDill AFB, and no wells drawing water from the surficial aquifer exist on the base. The Floridan Aquifer, although not used for water supplies at MacDill AFB, is a major source of water in west-central Florida and the Tampa area. Large well-fields exist north of Tampa which supply water to municipalities and industries. Water supply for MacDill AFB is provided from the Hillsborough River by the city of Tampa, Florida.

The Avon Park Air Force Range is located in central Florida in Polk and Highlands Counties approximately 65 miles east of Tampa. The local climate at Avon Park AFR is very similar to that described for MacDill AFB. Average annual precipitation is approximately 48 inches and average annual evapotranspiration is approximately 40 inches per year. Rainfall can be intense during the summer thunderstorm season, resulting in heavy runoff to surface water drainage features on the base.

The major surface water features at Avon Park AFR are Lake Arbuckle, Arbuckle Creek, and the surrounding wetlands. Lake Arbuckle is a sinkhole lake formed by subsidence of carbonite formations and may be hydraulically connected to the Floridan Aquifer System. Arbuckle Creek is the main drainage feature at the Auxiliary Airfield. It flows south to Lake Istokpoga through wetland areas which border the airfield on the west.

The local geology at Avon Park AFR consists of post-Miocene aged sands and clays which directly overlie the Miocene-aged Hawthorn Formation. Below the surface sand, which is approximately 20 feet thick, the Hawthorn Formation extends as a 300 foot thick sequence of clay, sand, and limestone which serves as a confining layer above the Floridan Aquifer.

Groundwater at Avon Park AFR occurs in the surficial aquifer under water-table conditions. The shallow aquifer is directly connected to the surface water drainage on the base. The water-table aquifer is recharged by infiltration of precipitation, and movement within this zone is very slow due to low hydraulic gradients. Discharge of groundwater from this zone may occur by evapotranspiration or lateral seepage into a stream, lake, or drainage ditch.

The Floridan Aquifer occurs under confined conditions beneath Avon Park AFR. The clay beds of the Hawthorn Formation form a 300 foot thick confining layer that limits vertical downward movement of water from the surficial aquifer and the vertical upward movement of water from the Floridan Aquifer. Interconnection between the two aquifers may occur where sinkholes have breached the Hawthorn Formation. The Floridan Aquifer, specifically the lower portion of the Avon Park Formation, previously called the Lake City Limestone, provides nearly all the municipal and irrigation water supplies in the area. Avon Park AFR receives its water supply from two wells located near Lake Arbuckle and two wells located near the airfield.

FIELD INVESTIGATION PROGRAM

The field program at MacDill AFB and Avon Park AFR involved work at twelve sites as summarized in Table 2. This work involved geophysical surveys (electrical resistivity, magnetic, and electromagnetic), drilling and installation of 27 shallow monitoring wells and 3 deeper monitoring wells, an aquifer pumping test in the surficial aquifer, and collection and analysis of groundwater, surface water, sediment, and soil samples. Field work began in July 1986 and laboratory analyses were completed in December 1986. A second round of groundwater and surface water samples were collected from selected sites in August 1987.

TABLE 2
SUMMARY OF THE FIELD PROGRAM FOR THE IRP PHASE II-STAGE 2
INVESTIGATION AT MACDILL AFB AND AVON PARK AFB

Site Name	Field Activities	Number & Kind of Samples	Sample Analysis	Analysis Method
<u>First Field Investigation, October 1986</u>				
Site B - Former Fuel Storage Area No. 2	Perform geophysical surveys - electrical resistivity and magnetic.	Four groundwater samples	Purgeable Organics with Xylene	E601, SW5030/8020
	Install four shallow monitoring wells.		EDB	E502.1
			Petroleum Hydrocarbons	E418.1
			Lead	E239.2
Site 3 - Landfill at Dog Kennel	Sample four new monitoring wells.			
	Perform geophysical survey, electrical resistivity.	Seven sediment samples	Purgeable Organics	SW5030/8240
	Install one shallow monitoring well.		Base/Neutral and Acid	SW3550/8270
	Sample sediment and surface water from drainage ditches, seven locations.		Extractable Organics	SW1310/6010, SW7471
Sites 5-8 Past Landfills	Sample four monitoring wells - one new well, three existing wells.			
	Install two shallow monitoring wells.	Five surface water samples and four groundwater samples	Purgeable Organics	E601/602
	Sample sediment and surface water from drainage ditches, five locations.		Base/Neutral and Acid	E625
			Extractable Organics	E200.7/245.1
Sites 5-8 Past Landfills	Install two shallow monitoring wells.	Five sediment samples	Purgeable Organics	SW5030/8240
	Sample sediment and surface water from drainage ditches, five locations.		Base/Neutral and Acid	SW3550/8270
			Extractable Organics	SW1310/6010, SW7471
	Sample six monitoring wells - two new wells and four existing wells.	Five surface water and six groundwater samples	Purgeable Organics	E601/602
Site 9 - Recent Landfill	Perform geophysical survey, electrical resistivity.	Two sediment samples	Base/Neutral and Acid	E625
	Install four shallow monitoring wells.		Extractable Organics	E200.7/245.1
			Metals Scan	SW5030/8240
			Base/Neutral and Acid	SW3550/8270
Site 9 - Recent Landfill			Extractable Organics	SW1310/6010, SW7471
			Metals Scan	

TABLE 2
SUMMARY OF THE FIELD PROGRAM FOR THE IRP PHASE II-STAGE 2
INVESTIGATION AT MACDILL AFB AND AVON PARK AFB (Continued)

Site Name	Field Activities	Number & Kind of Samples	Sample Analysis	Analysis Method
Site 9 - Recent Landfill (cont)	Sample sediment and surface water from drainage ditch, two locations. Sample six monitoring wells - four new wells and two existing wells.	Two surface water and six groundwater samples	Purgeable Organics Base/Neutral and Acid Extractable Organics Metals Scan	E601/602 E625 E200.7/245.1
Site 11 - Chemical Munitions Burial Area	Further records search investigation. Sample sediment and surface water from canal, three locations.	Three sediment samples	Purgeable Organics Base/Neutral and Acid Extractable Organics Metals Scan	SW5030/8240 SW3550/8270 SW1310/6010, SW7471
Site 13 - Creosote Pit	Perform geophysical survey, electrical resistivity. Install three shallow monitoring wells. Sample three new monitoring wells.	Three surface water samples Three groundwater samples	Purgeable Organics Base/Neutral and Acid Extractable Organics Metals scan Base/Neutral and Acid Extractable Organics	E601/602 E625 E200.7/245.1 E625
Site 16 - Fuel Tank Farm	Sample sediment and surface water from ditch and canal, six locations.	Six surface water samples	Petroleum Hydrocarbons Purgeable Organics with Xylene FDR Lead	E418.1 E601, SW5030/8020 E502.1 E239.2
Site 17 - Drum Storage Area	Install one shallow monitoring well. Sample sediment and surface water from drainage ditch, three locations.	Six sediment samples Three sediment samples	Petroleum Hydrocarbons Purgeable Organics Lead Purgeable Organics Base/Neutral and Acid Extractable Organics Lead Cadmium Zinc Chromium	SW3550/E418.1 SW5030/8240 SW3050/7420 SW5030/8240 SW3550/8270 SW3050/7420 SW3050/7130 SW3050/7950 SW3050/7190

TABLE 2
SUMMARY OF THE FIELD PROGRAM FOR THE IPR PHASE II-STAGE 2
INVESTIGATION AT MACDILL AFB AND AVON PARK AFB (Continued)

Site Name	Field Activities	Number & Kind of Samples	Sample Analysis	Analysis Method
Site 17 - Drum Storage Area (Continued)	Sample three monitoring wells - one new well and two existing wells.	Three surface water and three groundwater samples	Purgeable Organics Base/Neutral and Acid Extractable Organics Lead Cadmium Zinc Chromium	E601/602 E625 E239.2 E213.2 E289.1 E218.2
Site 23 - Fire Training Areas	Perform geophysical survey, electrical resistivity. Install three monitoring wells, 50-70 feet deep. Install eight shallow monitoring wells and one shallow observation well. Conduct aquifer pumping test. Sample groundwater from six existing wells and up to eleven new wells.	Seventeen groundwater samples	Purgeable Organics Petroleum Hydrocarbons Lead	E601/602 E418.1 E239.2
Site AP-6 - Old Landfill, Avon Park	Install one shallow monitoring well. Sample sediment and surface water from rim canal, three locations. Sample four monitoring wells - one new well and three existing wells.	Three sediment samples Three surface water and four groundwater samples	Purgeable Organics Base/Neutral and Acid Extractable Organics Petroleum Hydrocarbons Metals Scan Purgeable Organics Base/Neutral and Acid Extractable Organics Petroleum Hydrocarbons Metals Scan	SW5030/8240 SW3550/8270 SW3550/E418.1 SW1310/6010, SW7471 E601/602 E625 E418.1 E200.7/245.1
Site AP-7 - Recent Landfill, Avon Park	Install one shallow monitoring well. Sample four monitoring wells - one new well and three existing wells.	Four groundwater samples	Purgeable Organics Base/Neutral and Acid Extractable Organics Petroleum Hydrocarbons Metals Scan	E601/602 E625 E418.1 E200.7/245.1
Site AP-9 - Army Test Area, Avon Park	Sample upper six inches of soil at ten locations.	Ten soil samples	Pioxins Herbicides	SW3550/8280 SW8150

TABLE 2
SUMMARY OF THE FIELD PROGRAM FOR THE IRP PHASE II-STAGE 2
INVESTIGATION AT MACDILL AFB AND AVON PARK AFB (Continued)

Site Name	Field Activities	Number & Kind of Samples	Sample Analysis	Analysis Method
Second Field Investigation, August 1987				
Site B - Former Fuel Storage Area No. 2	Install one shallow monitoring well.	Five groundwater samples	Purgeable Organics with Xylene	E601, SW5030/8020
	Sample five monitoring wells.		Petroleum Hydrocarbons	E418.1
			Lead	E239.2
Site 3 - Landfill at Dog Kennel	Sample four monitoring wells.	Four groundwater samples and five surface water samples	Base/Neutral and Acid Extractable Organics	E625
	Sample five surface water stations.			
Site 5-8 - Past Landfills	Sample six monitoring wells and five surface water stations.	Six groundwater and five surface water samples	Purgeable Organics Base/Neutral and Acid Extractable Organics	E601/602 E625
Site 9 - Recent Landfill	Sample six monitoring wells and four surface water stations.	Six groundwater and four surface water samples	Purgeable Organics Base/Neutral and Acid Extractable Organics	E601/602 E625
Site 11 - Chemical Munitions Burial Area	Perform EM and Magnetic Survey.			
Site 17 - Drum Storage Area	Install one shallow monitoring well.	Four groundwater and two surface water samples	Purgeable Organics Base/Neutral and Acid Extractable Organics	E601/602 E625
	Sample four monitoring wells and two surface water stations.			

E Method - USEPA, Federal Register, Vol. 49, No. 209, 26 Oct 1984.

SW Method - Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.
SW 846 - Second Edition, USEPA, 1984.

RESULTS AND SIGNIFICANCE OF FINDINGS

Contaminants were found at levels of concern at four sites on MacDill AFB (Sites 5-8, 9, 17, and 23). No significant contaminants were found at two sites on MacDill AFB (Sites 3 and 13) or at the three sites at Avon Park AFR. However, additional data are required to properly evaluate the three other sites at MacDill AFB (Sites B, 11, 16) before they can be dropped from further consideration. The findings at the twelve sites are summarized in Table 3. The significance of these findings was determined from consideration of the amount and extent of contaminants present, their potential for migration, and the potential threat posed to human health and the environment.

RECOMMENDATIONS

Based on the results obtained, each of the 12 IRP sites was classified in one of three categories of recommendations. Category I sites are those for which no further action is required. Data for these sites are considered sufficient to conclude that no significant threat to human health or the environment exists. Category II sites are those which require additional monitoring or investigation (Phase II, Stage 3) to assess the extent and potential for migration of the contaminants detected. Category III sites are those which require remedial actions (Phase IV), including long-term monitoring. Data for these sites are considered sufficient to characterize the extent of contamination or they indicate that an immediate threat to human health or the environment exists.

Recommendations for the 12 individual sites are summarized in Table 4. Six sites were recommended for further investigation (Phase II, Stage 3):

- o Former Fuel Storage Area No. 2 (Site B)
- o Past Landfills (Site No. 5-8)
- o Recent Landfill (Site No. 9)
- o Chemical Munitions Burial Area (Site No. 11)
- o Fuel Tank Farm (Site No. 16)
- o Drum Storage Area (Site No. 17)

TABLE 3
SUMMARY OF FINDINGS BY SITES

Site Number	Site Name	Significant Results and Major Conclusions
Site B	Former Fuel Storage Area No. 2	Fuel related contaminants were found at trace concentrations in the upgradient monitoring well. The abandoned tanks at this site need to be addressed (removal or continued monitoring).
Site No. 3	Landfill at Dog Kennel (DK)	No significant contamination found at this site.
Site No. 5-8	Past Landfills (PL)	Purgeable halocarbons and purgeable aromatics detected in two groundwater samples from the same well and one surface water sample.
Site No. 9	Recent Landfill (RL)	Benzene detected and confirmed in one well and chromium detected in another well at the site.
Site No. 11	Chemical Munitions Burial Area (CM)	No significant contamination found at this site. The reported burial areas have not been located or investigated.
Site No. 13	Old Creosote Pit (CP)	No contamination found at this site.
Site No. 16	Fuel Tank Farm (FT)	No significant contamination was found at this site. Groundwater has not been investigated.
Site No. 17	Drum Storage Area (DS)	Purgeable halocarbons and purgeable aromatics were confirmed in one downgradient well.

TABLE 3
SUMMARY OF FINDINGS BY SITES
(Continued)

Site Number	Site Name	Significant Results and Major Conclusions
Site No. 23	Fire Training Area (FA)	Purgeable aromatics (fuel related compounds) were detected in wells near the active and inactive burn pits. Petroleum hydrocarbons were detected in the surficial aquifer and in the Floridan Aquifer. A possible continuing source of contamination was identified.
Site No. AP6	Old Landfill, Avon Park AFR	No significant contamination was found at this site.
Site No. AP7	Recent Landfill, Avon Park AFR	No significant contamination was found at this site.
Site No. AP9	Army Test Area, Avon Park AFR	No contamination was found at this site.

TABLE 4
SUMMARY OF RECOMMENDATIONS BY CATEGORY

Site Category	Site Identifier	Recommendations	Rationale for Recommendation
Category I	Site No. 3	No further action	No significant contamination was found to warrant additional study or remediation.
	Site No. 13		
	Site No. AP6		
	Site No. AP7		
	Site No. AP9		
Category II	Site No. 5-8	Further investigation	Contaminants were detected at levels of concern, but the extent of contamination is unknown. Additional work is required to determine if human health or the environment is threatened.
	Site No. 9		
	Site No. 17		
	Site B		
	Site No. 11		
Category III	Site No. 16	Further investigation	No contaminants were detected at levels of concern in samples collected from these sites, but the field work did not adequately evaluate the potential for contamination. Additional work is needed to confirm or deny the presence of potential contaminants at these sites, and whether they are a threat to human health or the environment.
	Site No. 23		
	Phase IV, remedial actions		
Category III	Site No. 23	Phase IV, remedial actions	Contaminants were found at levels of concern. The potential exists for contaminant migration into the Floridan Aquifer. The contaminant source is a continuing threat to the environment.

The recommended Phase II, Stage 3 field investigation program for these sites are summarized in Table 5. One site was recommended for remedial action (Phase IV):

- o Fire Training Area (Site No. 23)

No further action was recommended for the remaining 5 IRP sites:

- o Landfill at Dog Kennel (Site No. 3)
- o Old Creosote Pit (Site No. 13)
- o Old Landfill, Avon Park AFR (Site No. AP6)
- o Recent Landfill, Avon Park AFR (Site No. AP7)
- o Army Test Area, Avon Park AFR (Site No. AP9)

TABLE 5
SUMMARY OF RECOMMENDED CATEGORY II INVESTIGATIONS BY SITE

Site Number	Site Name	Description of Additional Field Activities	Description of Additional Analytical Activities
Site No. 5-8	Past Landfills	<p>Installation of five shallow monitoring wells (approx. 20 feet deep) and one boring into the clay confining layer with option of completion in Floridan aquifer.</p> <p>Collection and analysis of eleven groundwater samples and five surface water samples.</p> <p>Risk assessment.</p>	<p>Eleven water samples for purgeable organics (SW8010/8020)</p>
Site No. 9	Recent Landfill	<p>Collection and analysis of six groundwater samples.</p> <p>Collection of four surface water samples at low tide and analysis.</p> <p>Risk assessment.</p>	<p>Ten water samples for purgeable organics (SW8010/8020) and metals (E200.7, E245.1)</p>
Site No. 17	Drum Storage	<p>Installation of two shallow monitoring wells (approx. 20 feet deep).</p> <p>Ten soil borings with split spoon samples.</p> <p>Collection and analysis of six groundwater samples and two surface water samples.</p> <p>Risk Assessment.</p>	<p>Eight water samples for purgeable organics (SW8010/8020)</p> <p>Approximately thirty soil samples for purgeable organics (SW8010/8020)</p>

TABLE 5 (Continued)
SUMMARY OF RECOMMENDED CATEGORY II INVESTIGATIONS BY SITE

Site Number	Site Name	Description of Additional Field Activities	Description of Additional Analytical Activities
Site B	Former Fuel Storage Area No. 2	Continued monitoring of existing wells and removal of abandoned underground fuel tanks.	Purgeable organics (SW8010/8020) Petroleum Hydrocarbons (E418.1)
Site No. 11	Chemical Munitions Burial Area	Records search and interviews. Define and characterize burial area.	
Site No. 16	Fuel Tank Farm	Installation of three shallow monitoring wells (approx. 20 feet deep). Collection and analysis of three groundwater samples.	Three water samples for purgeable organics (SW8010/8020) and petroleum hydrocarbons (E418.1)

SECTION 1
INTRODUCTION

SECTION 1

INTRODUCTION

1.1 BACKGROUND AND AUTHORITY

The United States Air Force, due to its primary mission of defense of the United States, has long been engaged in a wide variety of operations involving toxic and hazardous materials. Federal, State and local governments have developed strict regulations that require disposers to identify the locations and contents of past disposal sites and to take action to eliminate the hazards in an environmentally responsible manner. The primary Federal legislation governing disposal of hazardous waste is the Resource Conservation and Recovery Act (RCRA) of 1976, as amended. Under Section 6003 of the Act, Federal agencies are directed to assist the Environmental Protection Agency (EPA). Under Section 3012, State agencies are required to inventory past disposal sites, and EPA is required to provide information concerning such sites (including information obtained from other Federal agencies) at the request of the State agencies.

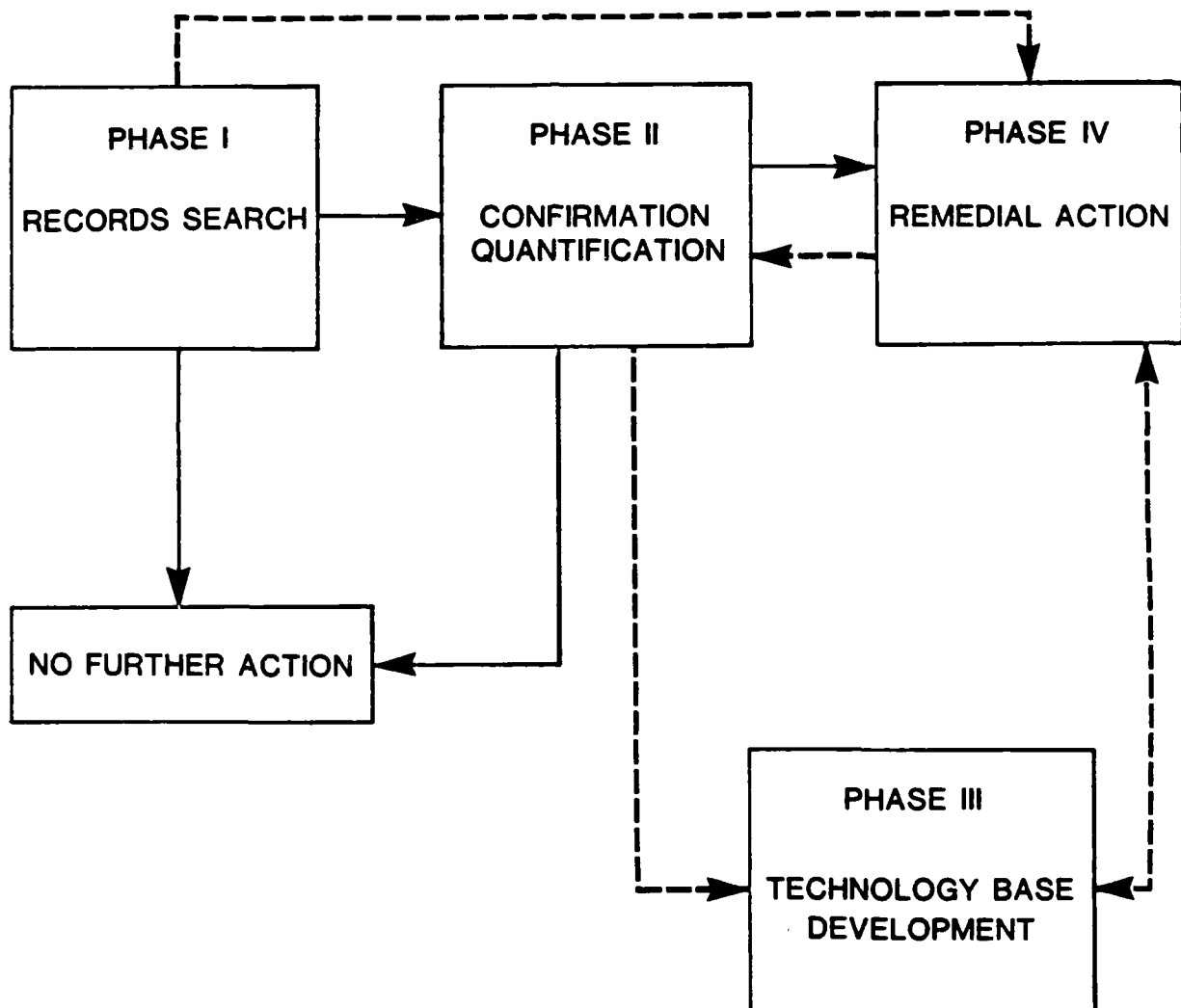
To assure compliance with hazardous waste regulations, the Department of Defense (DOD) developed the Installation Restoration Program (IRP). The current DOD IRP policy is contained in Defense Environmental Quality Program Policy Memorandum (DEQPPM) 81-5, dated 11 December 1981 and implemented by Air Force message dated 21 January 1982. DEQPPM 81-5 reissued and amplified all previous directives and memoranda on the Installation Restoration Program. DOD policy is to identify and fully evaluate suspected problems associated with past waste disposal practices (including spills), and to control hazards to health and welfare that resulted from these operations. The IRP is the basis for remedial actions on Air Force installations under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, and clarified by Executive Order 12316. CERCLA is the primary legislation governing remedial action at past hazardous-waste disposal sites.

1.2 PURPOSE AND SCOPE

IRP activities are divided into four phases designed to provide timely and cost-effective identification, confirmation/quantification, and remedial action at past waste-disposal and spill sites (Figure 1.1). Each phase is briefly described below:

- o Phase I - Installation Assessment/Records Search - The purpose of Phase I is to identify past disposal sites that may pose a hazard to public health or the environment as a result of contaminant migration to surface or ground waters, or that may have an adverse effect by the persistence of contaminants in the environment. The need for further action to confirm an environmental hazard at a site is also determined in this phase, and the Phase I report is the principal background document for the Phase II study. If a site requires immediate remedial action, such as removal of abandoned drums, the recommended site activity may be to proceed directly to Phase IV.
- o Phase II - Confirmation/Quantification - The objectives of Phase II are to define and quantify, through preliminary and comprehensive environmental and/or ecological surveys, the presence or absence of contamination, the extent of contamination (including rate and direction of contaminant migration, when possible), and waste characteristics (when required by regulatory agencies). An additional objective is to identify sites or locations where remedial action is required in Phase IV. Research requirements identified during Phase II are addressed by Phase III efforts under the IRP.
- o Phase III - Technology Base Development - The purpose of Phase III is to develop a sound technological data base for use in preparing a comprehensive remedial action plan, including the development of new technology for waste treatment and site remediation. This phase can also include implementation of research requirements and technology for objective assessment

U.S. AIR FORCE INSTALLATION RESTORATION PROGRAM



SOURCE: AFESC

of adverse effects. A Phase III requirement can be identified at any time during the program.

- o Phase IV - Remedial Action - The primary purpose of Phase IV is to prepare and implement remedial action plans for contaminated sites identified in Phases I and II.

This report presents the results of the Phase II, Stage 2 (Confirmation/Quantification) investigation at MacDill Air Force Base near Tampa, Florida. The overall objectives of the Phase II effort are to define the magnitude, extent, direction and rate of movement of identified contaminants and to determine the need for remedial actions based on an assessment of risks to human health and the environment. Specific objectives of the Stage 2 investigation were to:

- o confirm the presence or absence of contamination at the identified past spill and waste-disposal sites,
- o determine the magnitude and extent of contamination and, where possible, the potential for migration of contaminants in the various environmental media,
- o identify potential environmental consequences and health risks of known contaminants, based on State or Federal standards and guidelines, and
- o identify any specific requirements for additional monitoring to confirm the magnitude, extent, migration, or identity of contaminants present.

1.3 PROGRAM SCHEDULE AND DURATION

The Phase I (Installation Assessment/Records Search) investigation of MacDill AFB was conducted by CH2M HILL, Inc. and was completed in November 1981 with submittal of the Final Report (CH2M HILL, 1981). The Phase II, Stage 1 Investigation was conducted by Water and Air Research, Inc. and was completed in September, 1984 (WAR, 1984). The Phase II, Stage 2 (Confirmation/Quantification) investigation was initiated in June 1986 by Engineering-Science, under Agreement F33615-84-D-4403, Delivery Order 0014. The Phase IV-A Investigation of Site A was conducted by R. A. Kirkner and Associates, Inc. and was completed in July, 1986 (Kirkner, 1986).

1.4 BACKGROUND INFORMATION

MacDill AFB is located on approximately 5,600 acres of land at the southern tip of the Interbay Peninsula, about eight miles from downtown Tampa, in Hillsborough County, Florida. The Interbay Peninsula lies between Hillsborough Bay on the east and Tampa Bay on the west. The location of MacDill AFB is shown on Figures 1.2 and 1.3.

Construction began in December 1939 for the Army Air Corps Base which later became MacDill AFB. The base was officially activated in April 1941. MacDill AFB served as a training base for bomber aircraft crews until after World War II, when the base became an operational base for the Strategic Air Command (SAC). In 1962 the base was transferred from SAC to the Tactical Air Command (TAC) where it has remained.

MacDill AFB's primary mission today is a training base for fighter squadrons. The host unit at MacDill AFB is the 56th Tactical Fighter Wing which is responsible for its overall operation and maintenance. The Wing's primary mission is to train pilots in the F-16 Fighting Falcon. Also located at MacDill AFB are several tenant units including: the U.S. Readiness Command; U.S. Central Command; 71st Tactical Control Flight; 1928 Communications Group; and the 56 TFW Hospital.

The 56th Tactical Fighter Wing is also responsible for maintaining facilities at the Fort Lonesome Radar Site and the Avon Park Air Force Range (AFR) shown in Figure 1.2. The Fort Lonesome Radar Site is supported jointly by MacDill AFB and the Federal Aviation Administration. The Avon Park AFR is located in Polk and Highland Counties and is operated by the 56th Combat Support Squadron which maintains facilities for bombing, strafing, and electronic warfare exercises for aircrew training. The Avon Park AFR was constructed in 1942 by the Army Air Corps to train air crews for service in World War II. The Florida Avon Park Correctional Institution was opened at the AFR in 1951 as a minimum security prison. In 1956 Avon Park AFR was assigned to SAC at MacDill AFB and was reassigned to the Tactical Air Command along with MacDill AFB in 1962. The Avon Park AFR is used as a bombing range by Air Force units throughout the southeast and for "live firing" exercises. An auxiliary airfield is also maintained at Avon Park AFR.

FIGURE 1.2

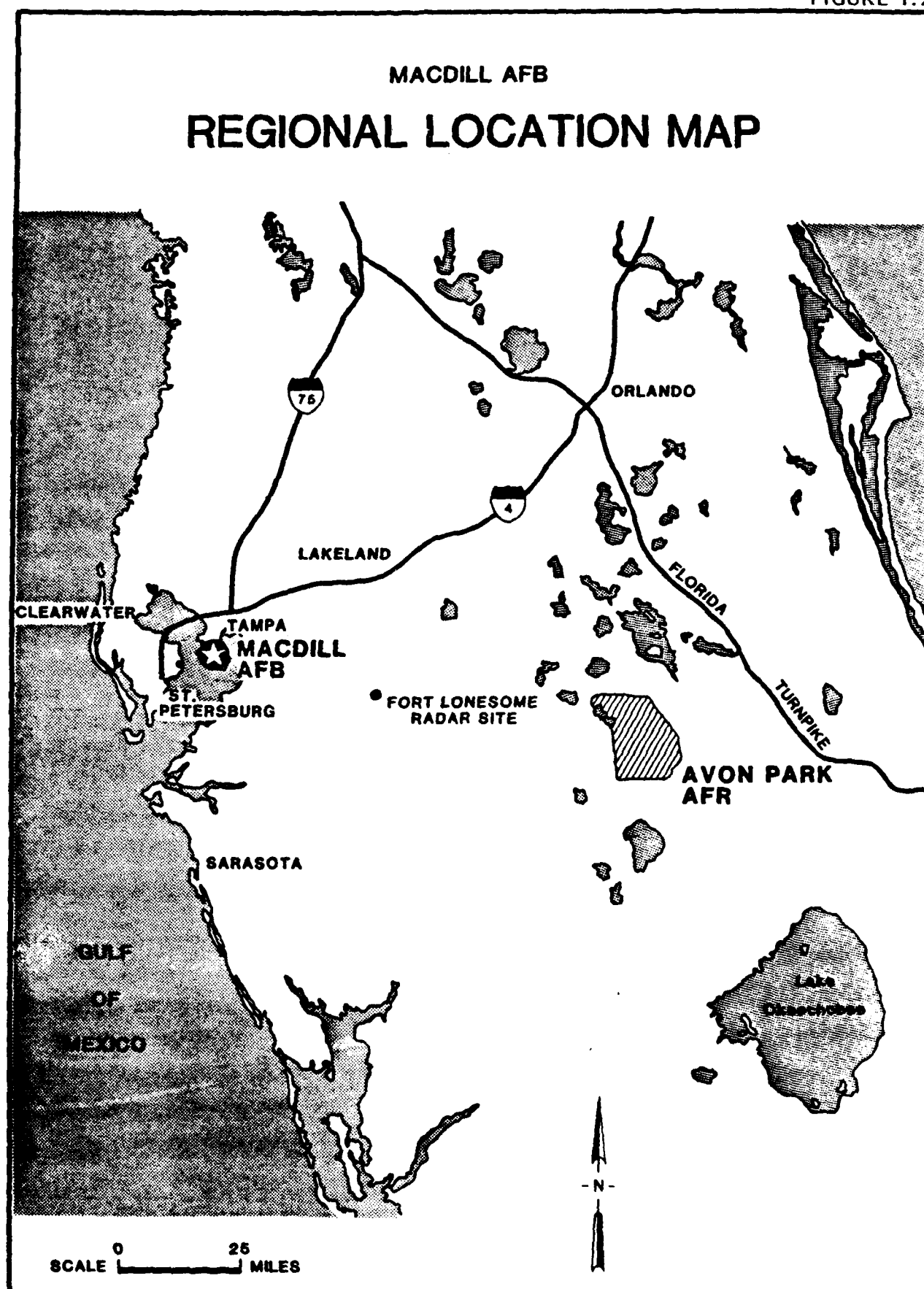
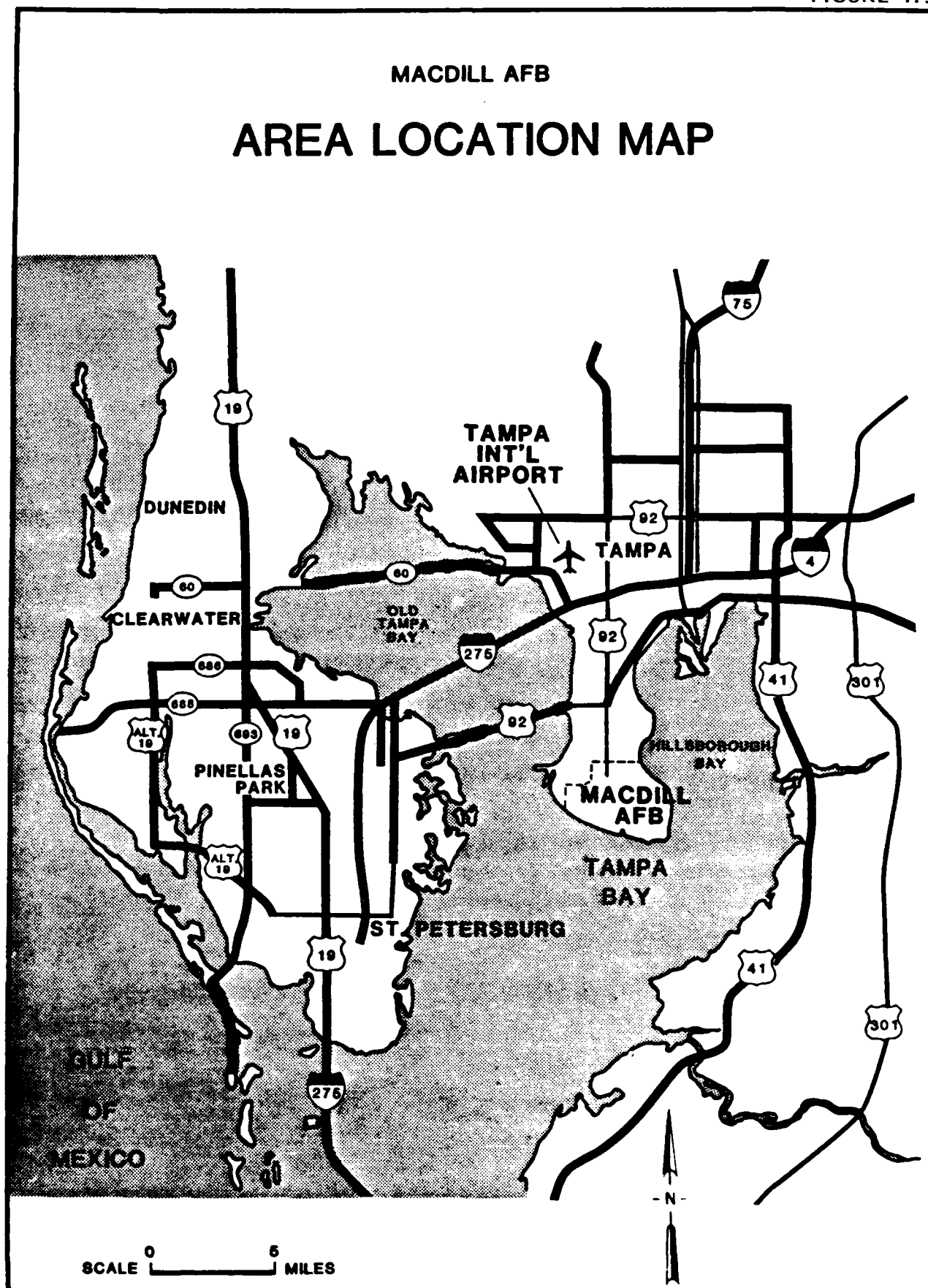


FIGURE 1.3



1.5 POTENTIALLY CONTAMINATED AREAS

The Phase I Records Search identified 23 sites of potential environmental concern at MacDill AFB and 11 sites at Avon Park AFR. Based on results of the Phase I survey (CH2M HILL, 1981), seven sites at MacDill AFB and three sites at Avon Park AFR were investigated under Phase II, Stage 1.

After the Phase II, Stage I study (WAR, 1984) one site at MacDill AFB (Site A, former fuel storage facility) was identified for remedial action under Phase IV. Six other sites at MacDill AFB were recommended for further investigation under Phase II, Stage 2. Of the three sites at Avon Park AFR, one was dropped from further consideration and two were recommended for investigation under Phase II, Stage 2. Two additional sites at MacDill AFB and one additional site at Avon Park AFR that were previously investigated under Phase I were added to the list of sites to be investigated under Phase II, Stage 2. One new site at MacDill AFB that was first identified in the Phase II, Stage 1 investigation was also added.

The total number of sites investigated in this Phase II, Stage 2 was twelve: nine sites at MacDill AFB and three sites at Avon Park AFR. The locations of these sites are shown in Figures 1.4 and 1.5, and the site histories are summarized in Table 1.1. A historical and physical description of each site investigated is presented below.

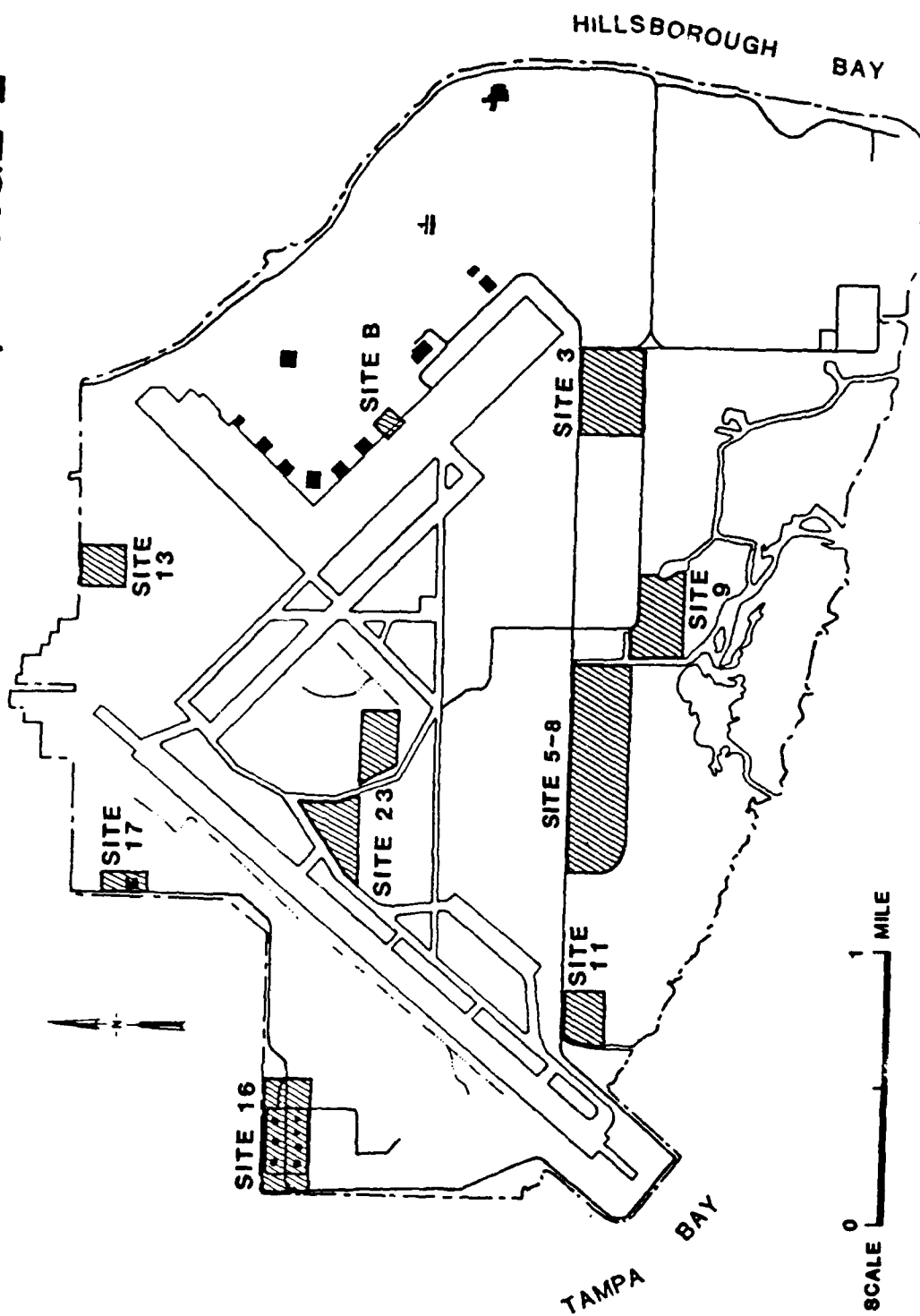
1.5.1 MacDill AFB

1.5.1.1 Site B - Former Fuel Storage Area No. 2

Site B is located on the southeastern limb of the flightline area (see Figure 1.4). The site, shown in detail in Figure 1.6, was formerly an underground fuel storage area. Twelve 25,000 gallon and one 12,000 gallon underground tanks were reportedly located at the site as part of an "Aqua System" which used water to displace fuel from underground storage tanks, forcing it into the distribution piping system (WAR, 1984). This system was put in use in the early 1950's and abandoned in 1972. Since then, at least one of the underground tanks was used to store waste solvents and contaminated fuels. This practice was discontinued in 1986. Site B was not previously investigated under either Phase I or Phase II IRP efforts.

FIGURE 1.4

MACDILL AFB
**LOCATION OF SITES
INVESTIGATED UNDER PHASE II, STAGE 2**



SOURCE: USGS 7.5 Minute Quadrangles.

FIGURE 1.5

AVON PARK AFR LOCATION OF SITES INVESTIGATED UNDER PHASE II, STAGE 2

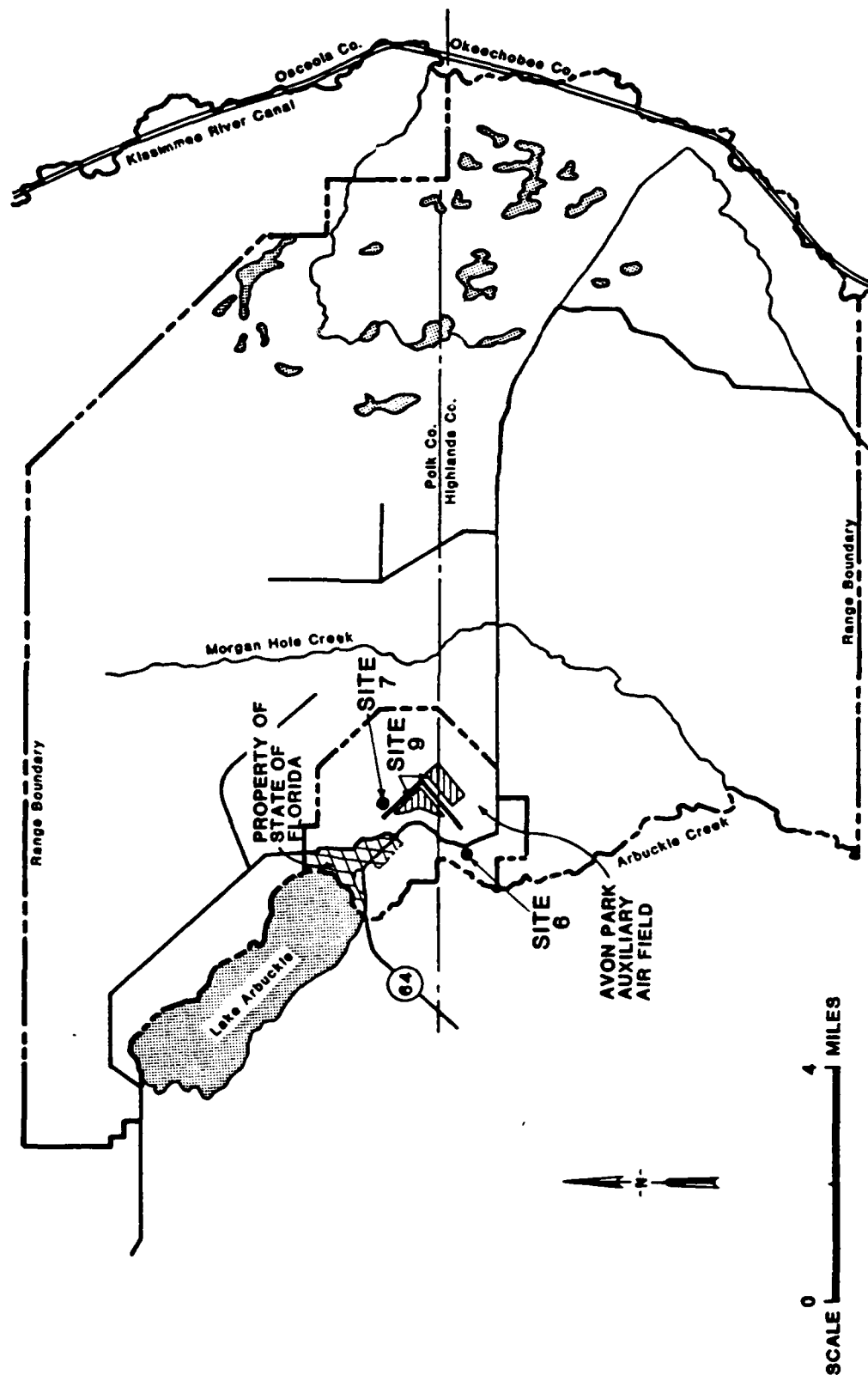
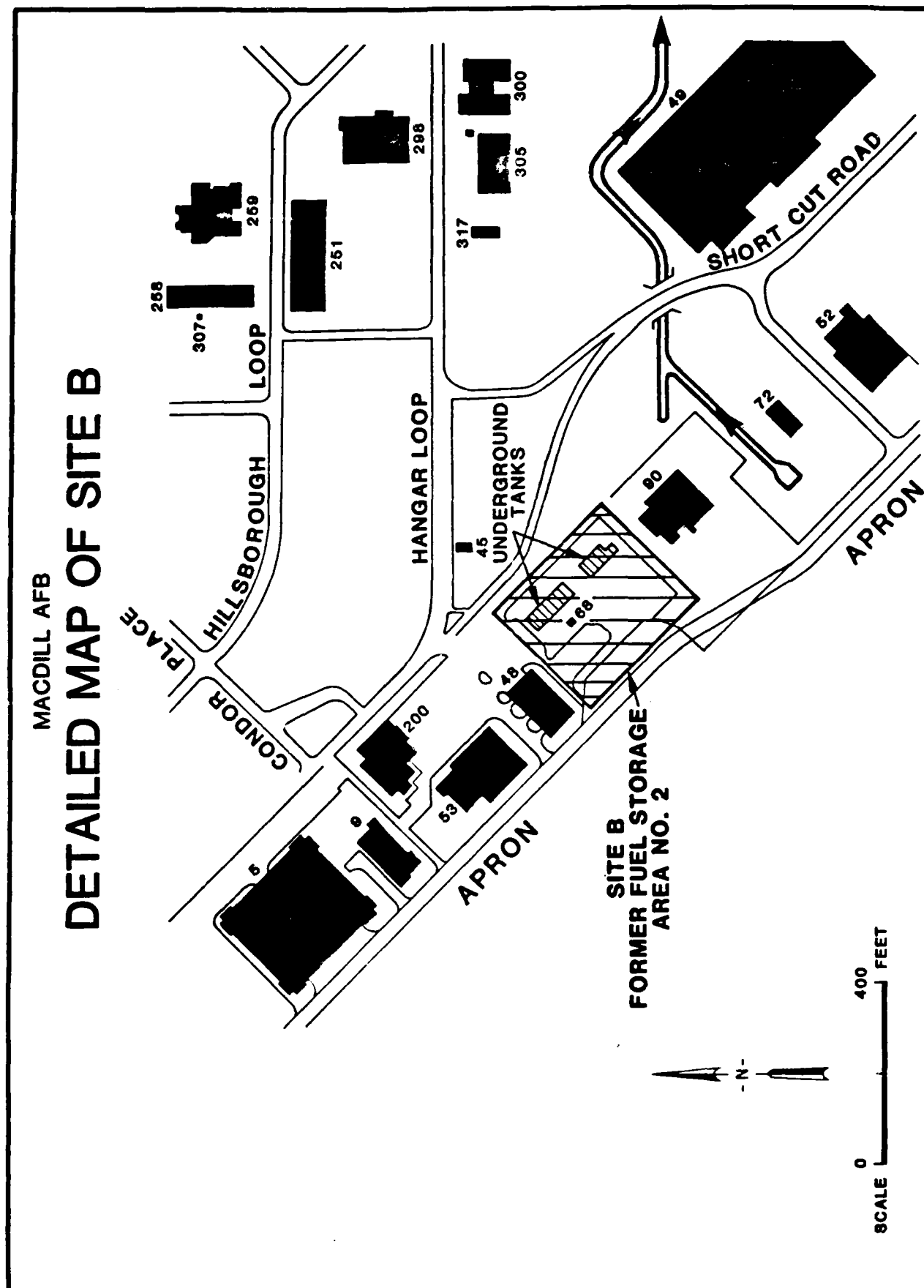


TABLE 1.1
SUMMARY OF IIP SITE HISTORIES
AT MONTICELLI AFB AND AVON PARK AFB

Site No.	Site Name	Period of Use	Suspected Wastes or Materials Stored, Spilled, or Disposed in the Past	Previous IIP Site Efforts
8	Former Fuel Storage Area No. 2	1950's to 1972	Contaminated fuel and waste solvents.	Not investigated previously
3	Landfill at Dog Kennel	1950 to 1959	General refuse, paint cans, solvents, PCB-containing capacitors.	Phase I Phase II, Stage 1
5-8	Past Landfills	1959 to 1973	General refuse and garbage, and small quantities of waste oil, solvents, paints, thinners, battery casings, pesticides, herbicides, PCB capacitors, adhesives, construction debris, and tires.	Phase I Phase II, Stage 1
9	Recent Landfill	1973 to 1986	General refuse and garbage, and small quantities of waste oil, solvents, paints, thinners, battery casings, pesticides, herbicides, PCB capacitors, adhesives, construction debris, and tires.	Phase I Phase II, Stage 1
11	Chemical Munitions Burial Area	1950 to 1955	Unknown chemicals.	Identified in Phase I
13	Creosote Pit	Prior to 1945	Creosote.	Identified in Phase I
16	Fuel Tank Farm	1952 to present	AVIACS sludge, tetraethyl lead, aviation gasoline, diesel fuel, JP-4, and JP-5.	Phase I Phase II, Stage 1
17	Drum Storage Area	1965 to present	PCB transformers, waste oils, solvents, paints, AVIACS sludge.	Phase I Phase II, Stage 1
23	Fire Training Area	1950's to present	Waste oils, contaminated fuel, solvents.	Phase I Phase II, Stage 1
AP-6	Old Landfill, Avon Park AFB	1950 to 1978	General refuse, garbage, suspected small quantities of unidentified hazardous wastes.	Phase I Phase II, Stage 1
AP-7	Recent Landfill, Avon Park AFB	1979 to 1985	General refuse, garbage, suspected small quantities of unidentified hazardous wastes.	Phase I Phase II, Stage 1
AP-9	Army Test Site, Avon Park AFB	1961 to 1965	Herbicides, dioxin.	Identified in Phase I

FIGURE 1.6



1.5.1.2 Site No. 3 - Landfill at Dog Kennel

Site No. 3 was a general refuse landfill that is located east of the munitions storage area and dog kennel, between Rattlesnake and Southshore Roads (Figure 1.7). The landfill was in operation from about 1950 to 1959 and was used for the disposal of general refuse, reportedly including paint cans, solvents and PCB-containing capacitors (CH2M HILL, 1981). Since closure, the site has been used as a spray irrigation field for effluent from the base sewage treatment plant.

Five shallow monitoring wells were installed and sampled during the Phase II, Stage 1 investigation (Figure 1.7). The analytical results from that investigation indicated possible organic contamination of the surficial aquifer. Analyses revealed levels of dissolved organic carbon (DOC) ranging from 16 to 80 mg/L and total organic halides (TOX) levels ranging from 110 to 260 ug/L as Cl. Conductivity values ranged from 280 to 3,660 umhos/cm, which may be a result of the spray irrigation or tidal influences. Wells MD3-2 and MD3-4 also showed small quantities of halogenated ethanes and toluene (2 to 11 ug/L) and traces of benzene (WAR, 1984). No PCB's were detected in samples from Site No. 3.

1.5.1.3 Site Nos. 5, 6, 7, 8 (No. 5-8) - Past Landfills

Site No. 5-8 consists of four landfills located south of Southshore Road in the southwestern portion of MacDill AFB (Figure 1.8). These landfills were used as general refuse landfills from about 1959 to 1973. It was reported (CH2M HILL, 1981) that some hazardous materials may have been disposed of in these landfills, including waste oil, solvents, paints, thinners, battery casings, pesticides, herbicides, adhesives, and PCB-containing capacitors, along with tires, construction rubble, and other refuse.

Four shallow monitoring wells were installed and sampled under Phase II, Stage 1 (Figure 1.8). The results of that investigation indicated possible organic contamination of the surficial aquifer, based on levels of DOC, TOX, and phenolics detected in groundwater samples. Analyses revealed levels of DOC ranging from 30 to 62 mg/L, TOX ranging from 100 to 240 ug/L as Cl, and phenolics ranging from 6 to 12 ug/L (WAR, 1984).

MACDILL AFB

DETAILED MAP OF SITE 3

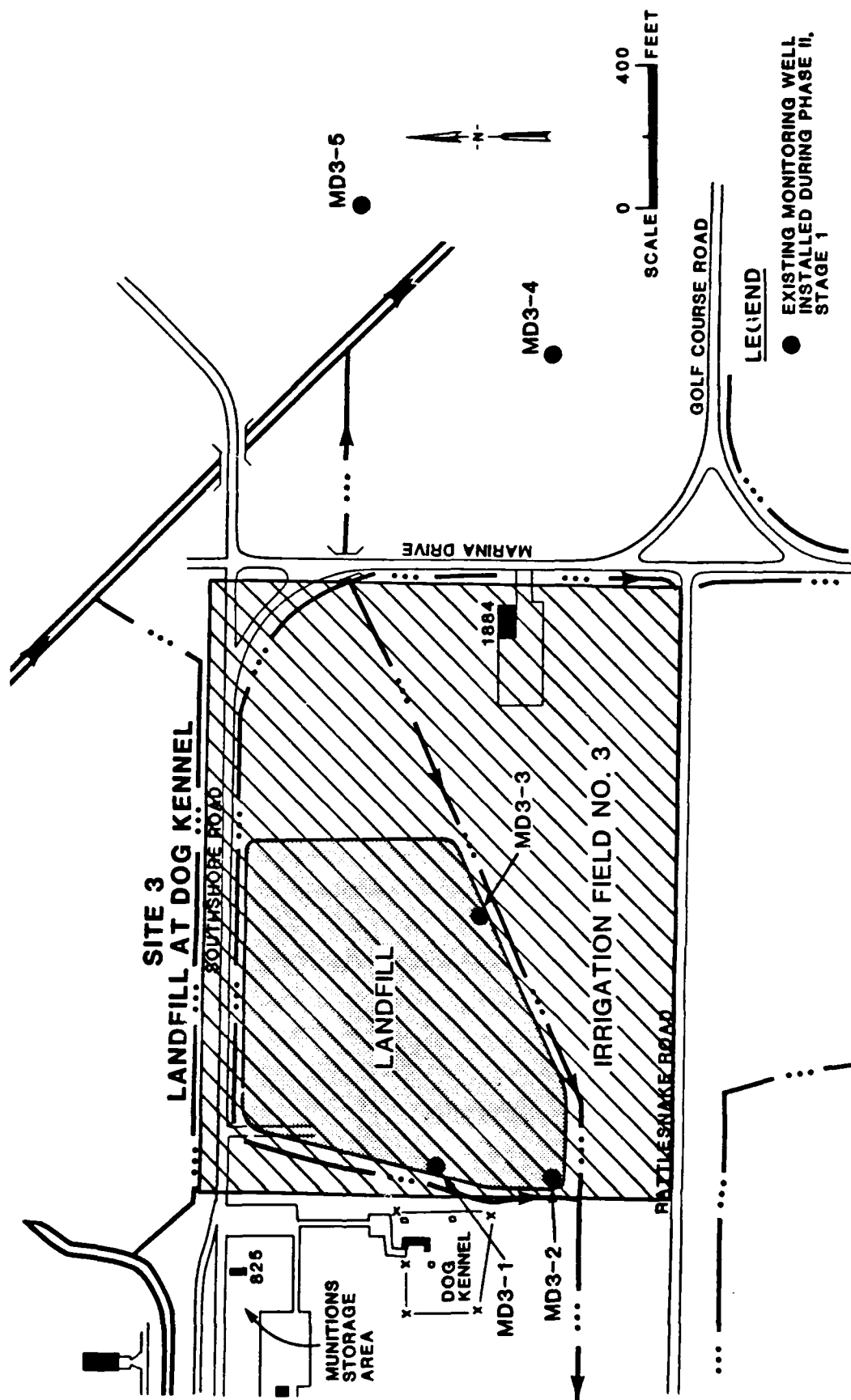


FIGURE 1.7

MACDILL AFB

DETAILED MAP OF SITE 5-8

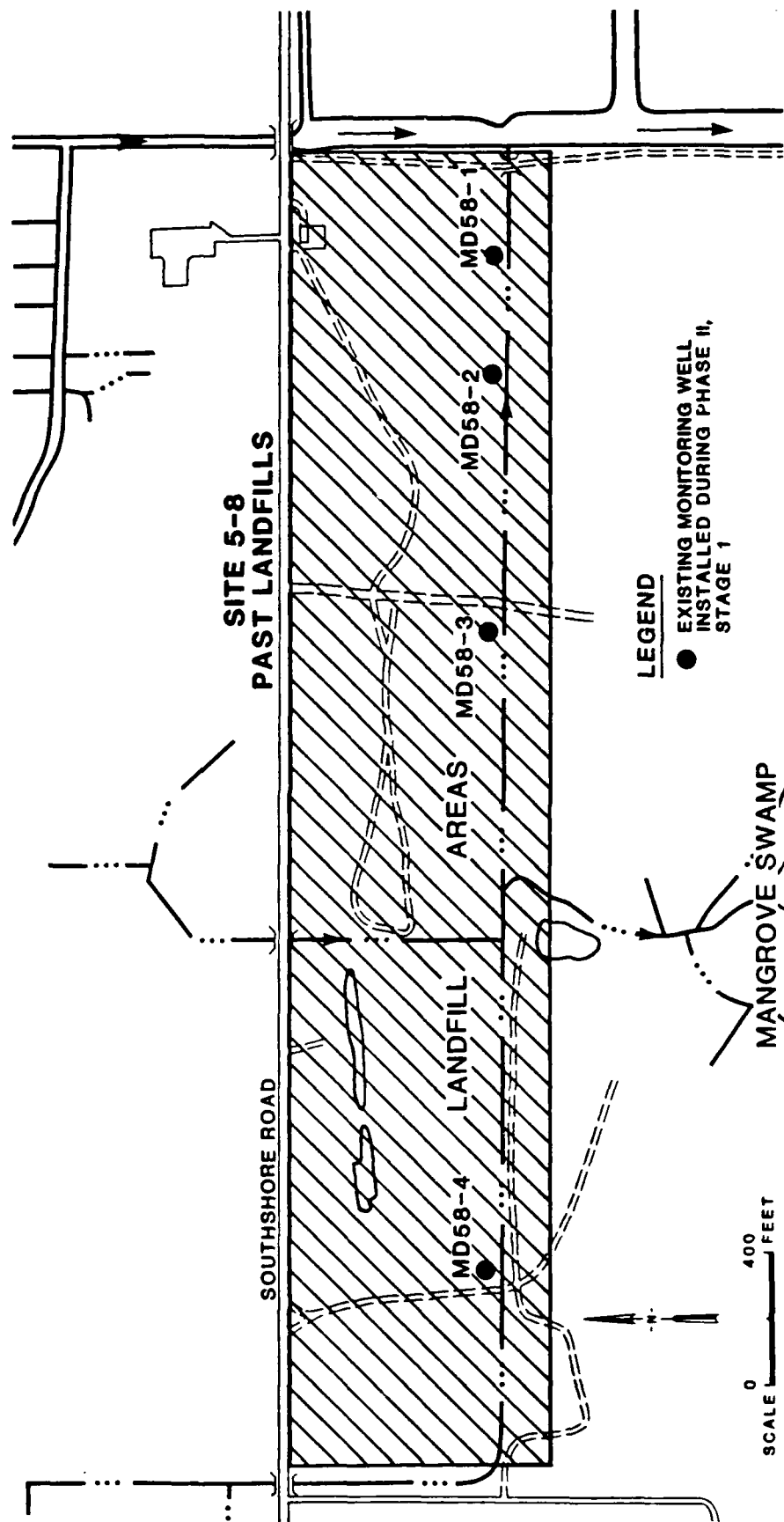


FIGURE 1.8

1.5.1.4 Site No. 9 - Recent Landfill

Site No. 9 was the most recent landfill used at MacDill AFB (Figure 1.9). It is located south-southwest of the munitions storage area and is bounded by Broad Creek on the east, west, and south. The landfill was used from about 1973 to early 1986, when it was closed, for the disposal of general refuse which may have included small quantities of waste oil, solvents, paints, thinners, battery casings, pesticides, herbicides, PCB-containing capacitors, and adhesives (CH2M HILL, 1981).

Three shallow monitoring wells were installed west and south of Site No. 9 (Figure 1.9) and sampled under Phase II, Stage 1. Results of the chemical analyses revealed possible organic contamination of the surficial aquifer, based upon the detected levels of DOC (34 to 141 mg/L), TOX (130-140 ug/L as Cl) and phenolics (1-8 ug/L) (WAR, 1984).

1.5.1.5 Site No. 11 - Chemical Munitions Burial Area

The Chemical Munitions Burial Area was reportedly located south of Southshore Road, adjacent to the drainage canal near the old SAC Alert Facility (Figure 1.10). This site may have been used for the disposal of unknown quantities and types of chemicals and chemical munitions during the period from about 1950 to 1955. The Phase I investigation reported that canisters of unidentified gases and deposits of white phosphorous were uncovered in this area and reburied (CH2M HILL, 1981). This site was not investigated under previous Phase II efforts.

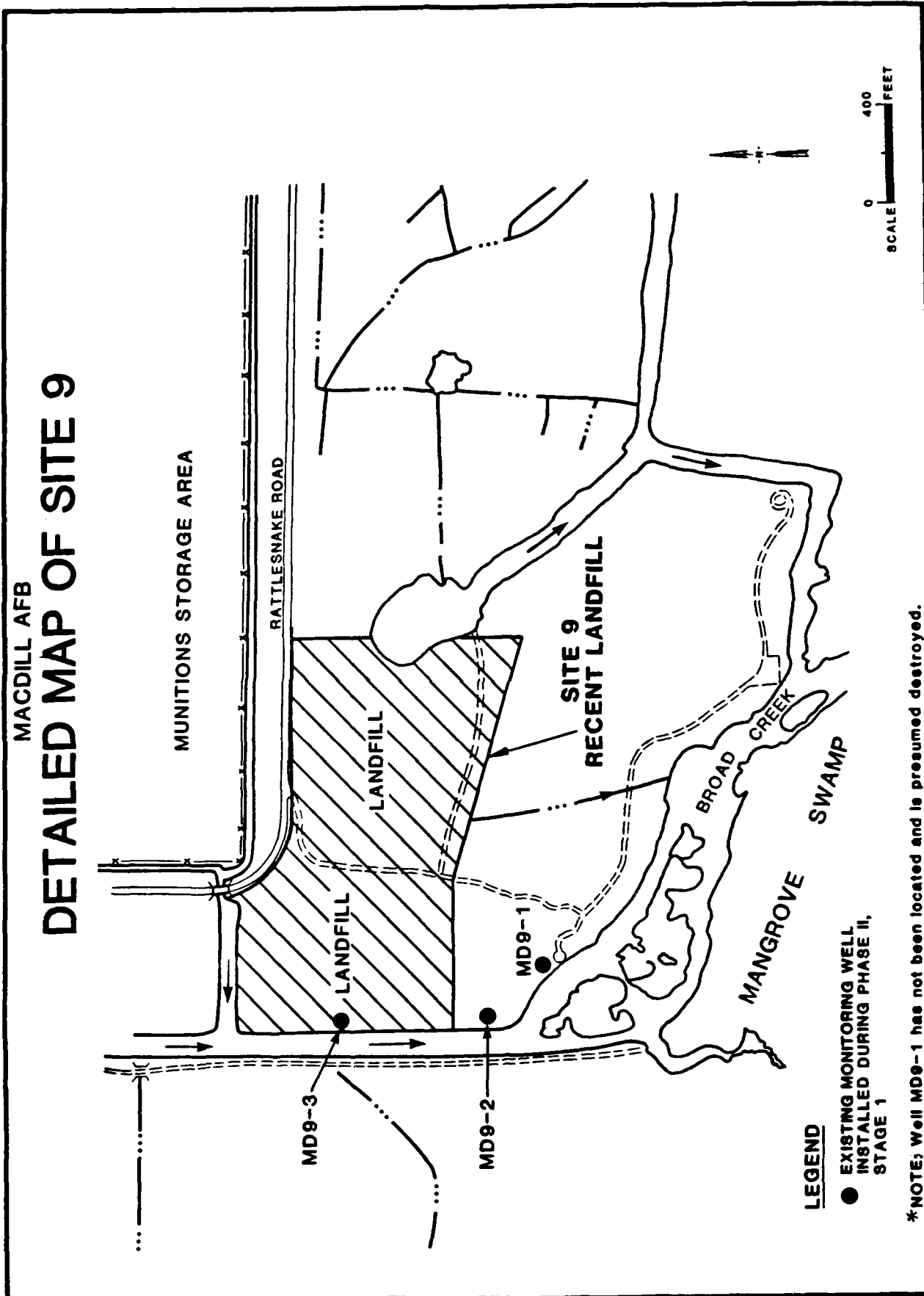
1.5.1.6 Site No. 13 - Creosote Pit

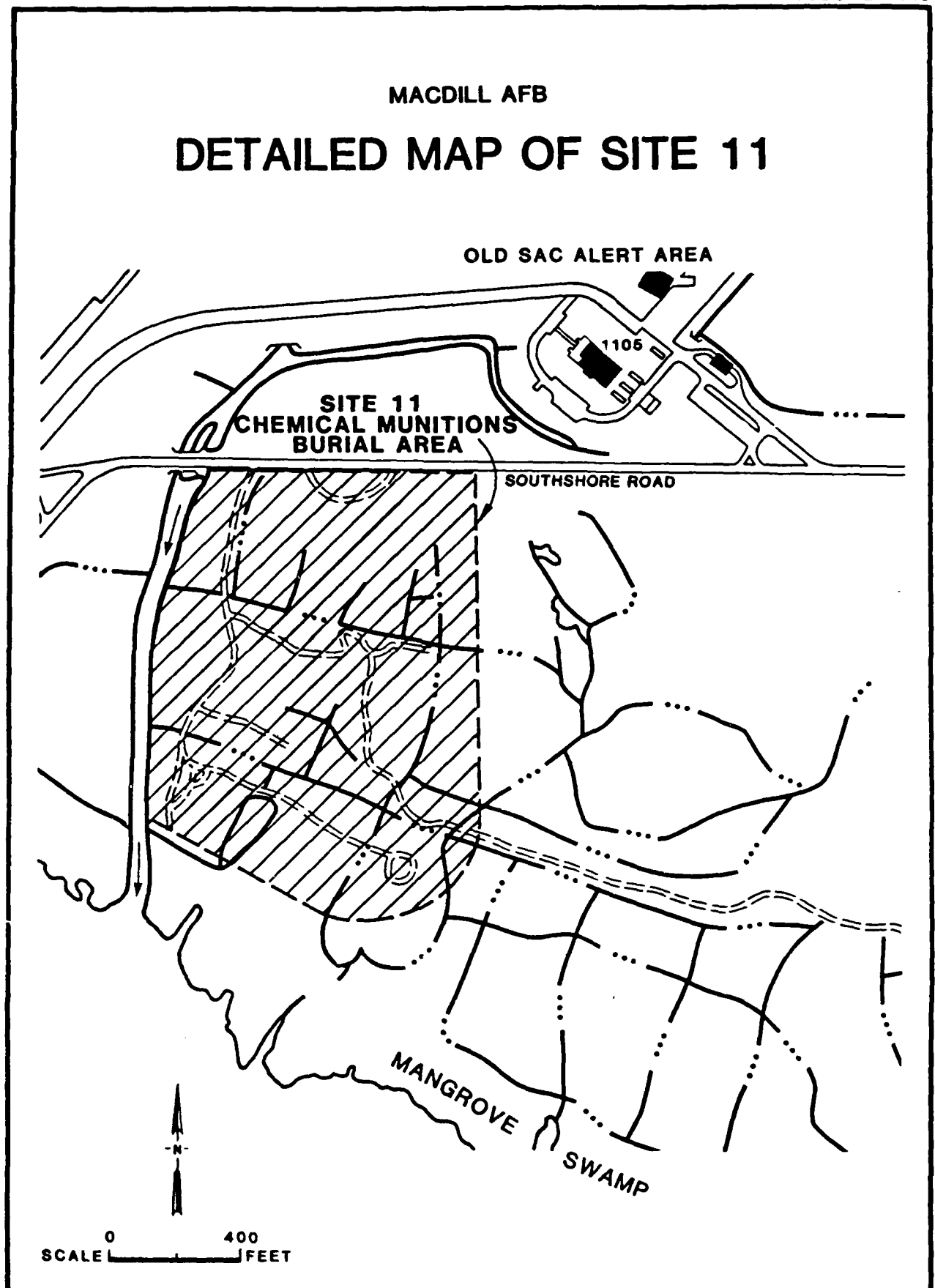
Site No. 13 is located west of the current Commissary Area near the stormwater retention pond, south of the North Boundary Road in the former CE storage yard (Figure 1.11). The site was reportedly used prior to 1945 for the creosote treatment of wood. No surface evidence of the pit remains, and no documentation of quantities of creosote used or lost is available. This site was identified during Phase I, but was not investigated under previous Phase II efforts.

1.5.1.7 Site No. 16 - Fuel Tank Farm

Site No. 16 is the bulk fuels storage area which consists of seven above-ground storage tanks (Figure 1.12). This tank farm has been in use since 1952 for storing AVGAS, diesel, JP-4, and JP-5 fuels. The tanks are surrounded by an earthen dike system for spill containment. The area outside the dike is drained to Tampa Bay by tidally influenced

FIGURE 1.9





MACDILL AFB

DETAILED MAP OF SITE 13

SITE 13
CREOSOTE PIT

NORTH BOUNDARY ROAD

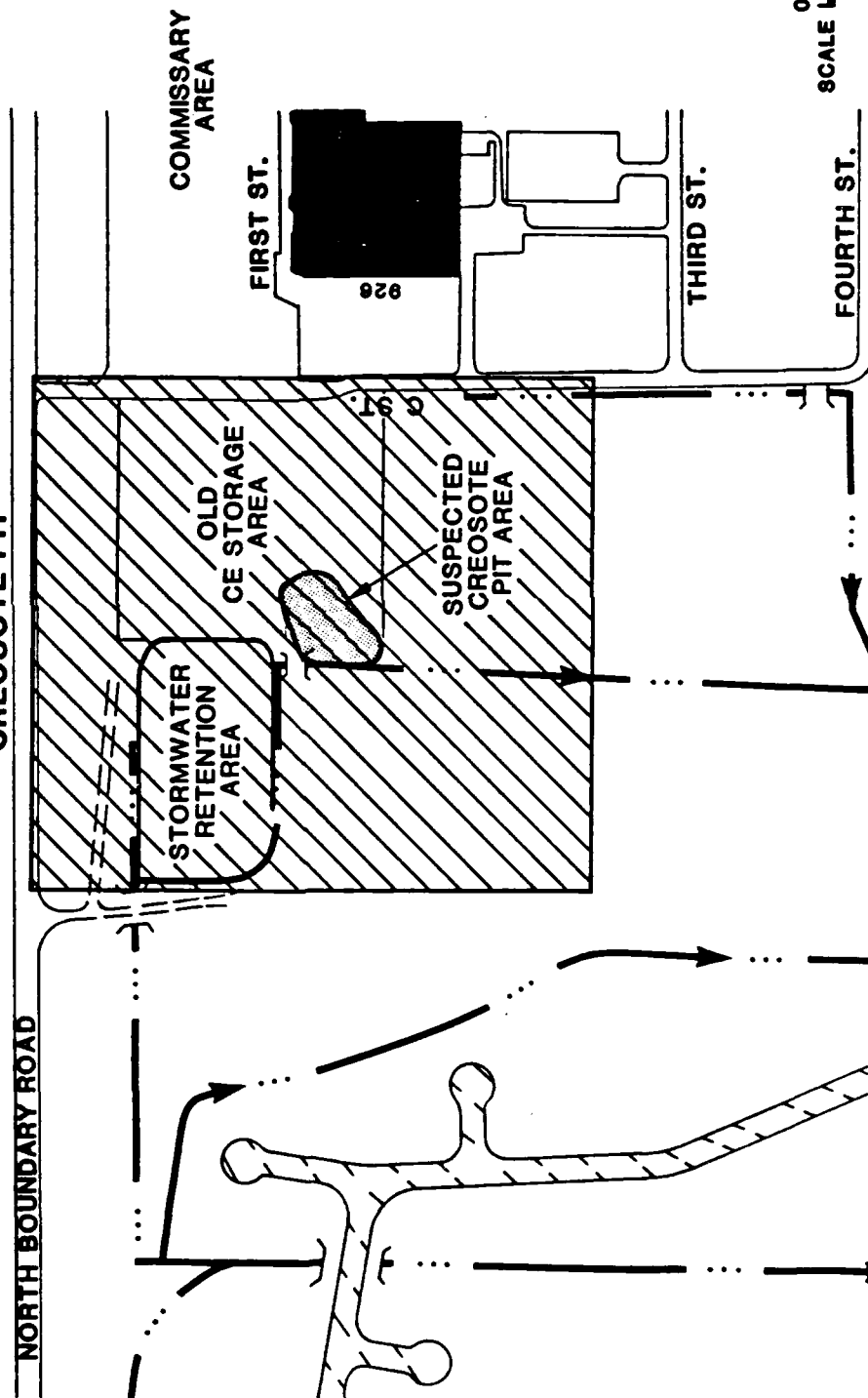
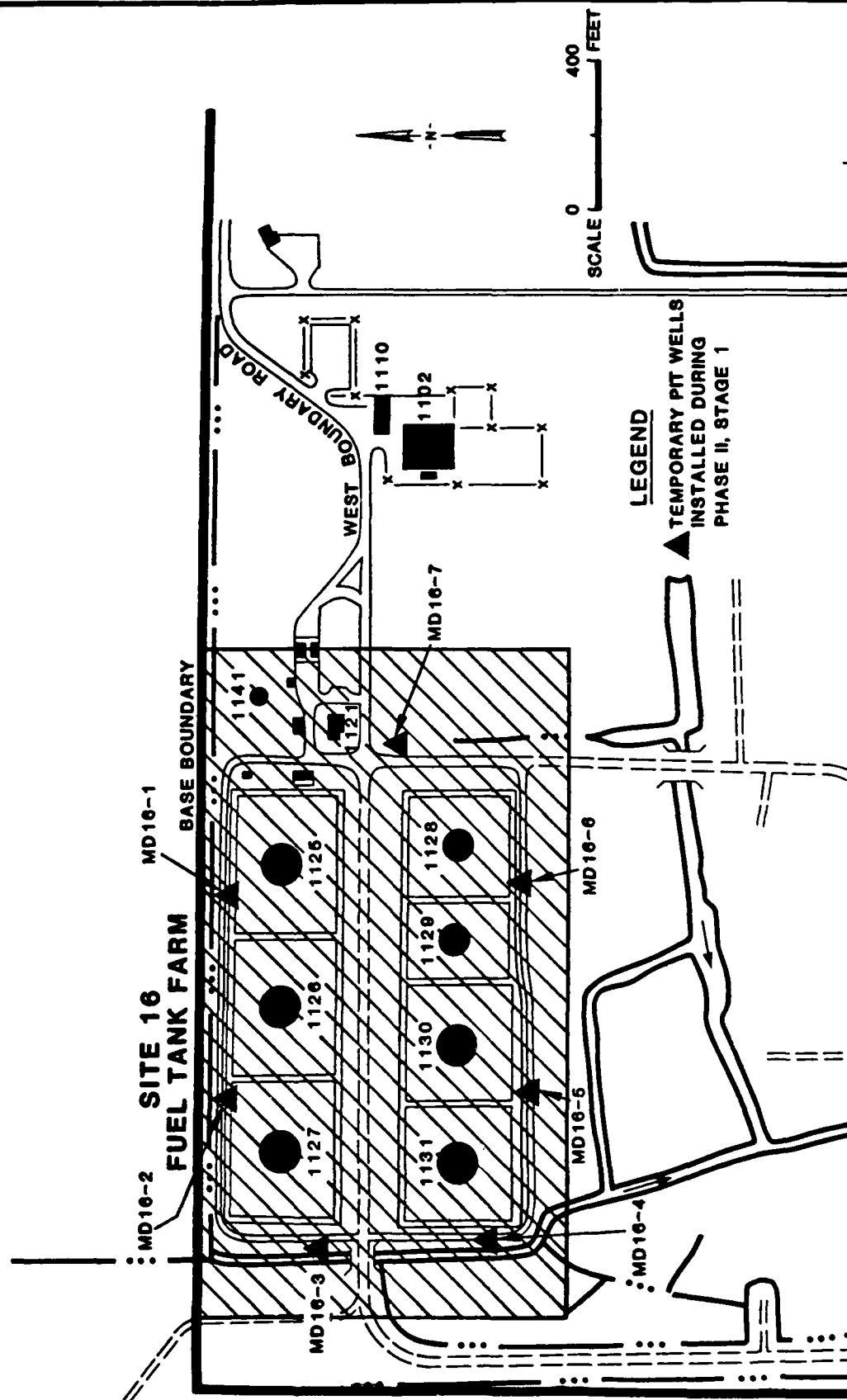


FIGURE 1.12

MACDILL AFB

DETAILED MAP OF SITE 16



ditches. AVGAS sludge was reportedly buried within the diked area. Phase II, Stage 1 work at Site No. 16 included installing, sampling, and backfilling seven shallow, temporary wells (Figure 1.12). The results of this work indicated possible organic contamination in the surficial aquifer based upon the results of chemical analyses. Samples collected at Site No. 16 showed levels of oil and grease ranging from <0.1 to 39 mg/L. Lead was found in well MD16-1 at 40 ug/L.

1.5.1.8 Site No. 17 - Drum Storage Area

Site No. 17, located near the intersection of the North Boundary Road and West Boundary Road (Figure 1.13), was a storage area for drums containing waste oils, solvents, and paints, and for out-of-service electrical transformers containing PCBs. The drums were stored on an open concrete pad and the transformers were stored in a protected building. From 1965 to 1973, AVGAS sludge was spread on this pad for weathering prior to disposal.

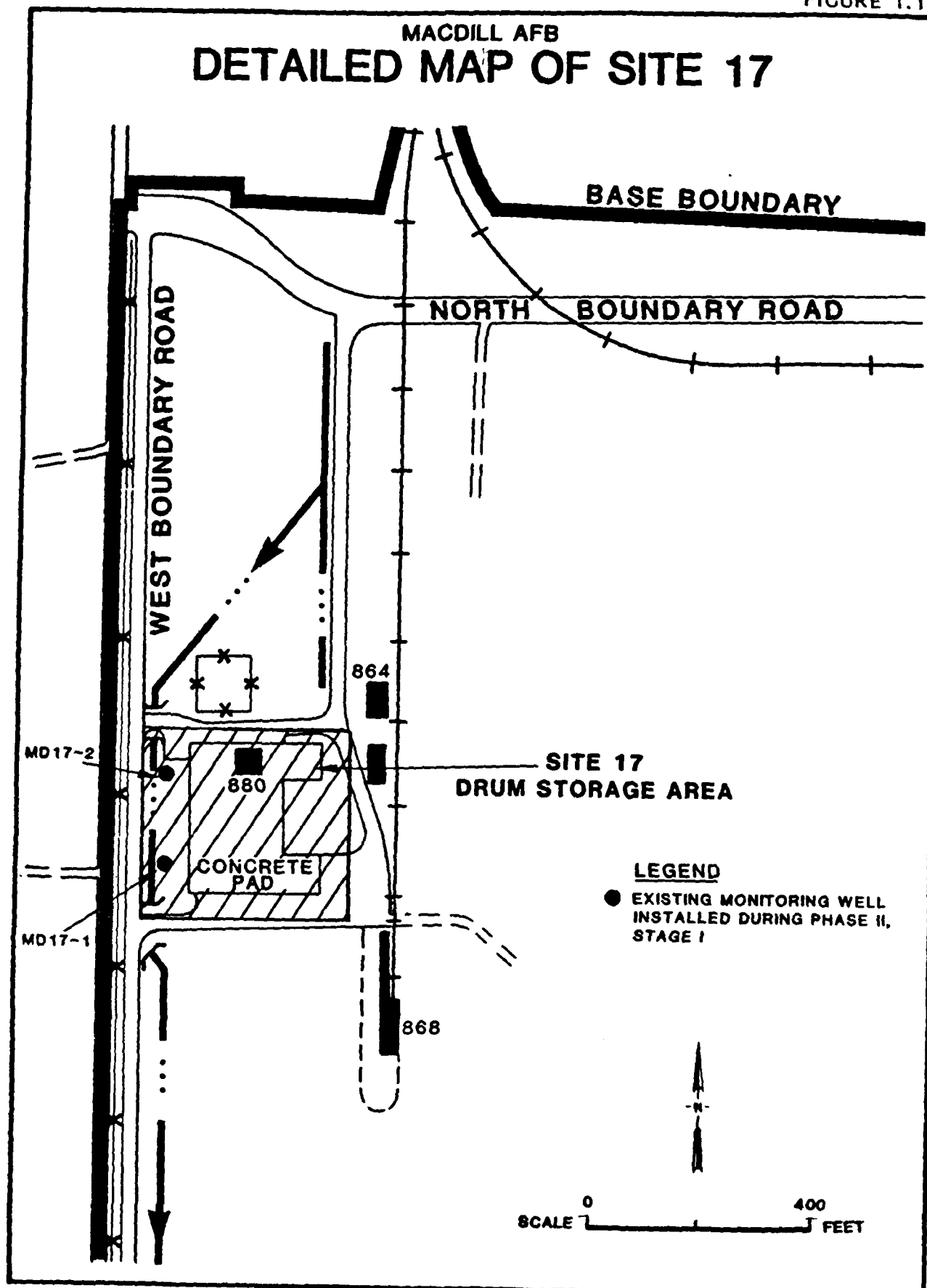
Phase II, Stage 1 work at Site No. 17 included installation and sampling of two shallow groundwater monitoring wells located along the West Boundary Road (Figure 1.13). This work indicated possible organic contamination in the surficial aquifer, based on the chemical analyses results. Well MD17-1 showed DOC at 21 mg/L, TOX at 110 ug/L as Cl, and phenolics at 10 ug/L. Well MD17-2 showed DOC at 26 mg/L, TOX at 120 ug/L as Cl, and phenolics at 8 ug/L. No PCB's were detected in any groundwater samples at Site No. 17.

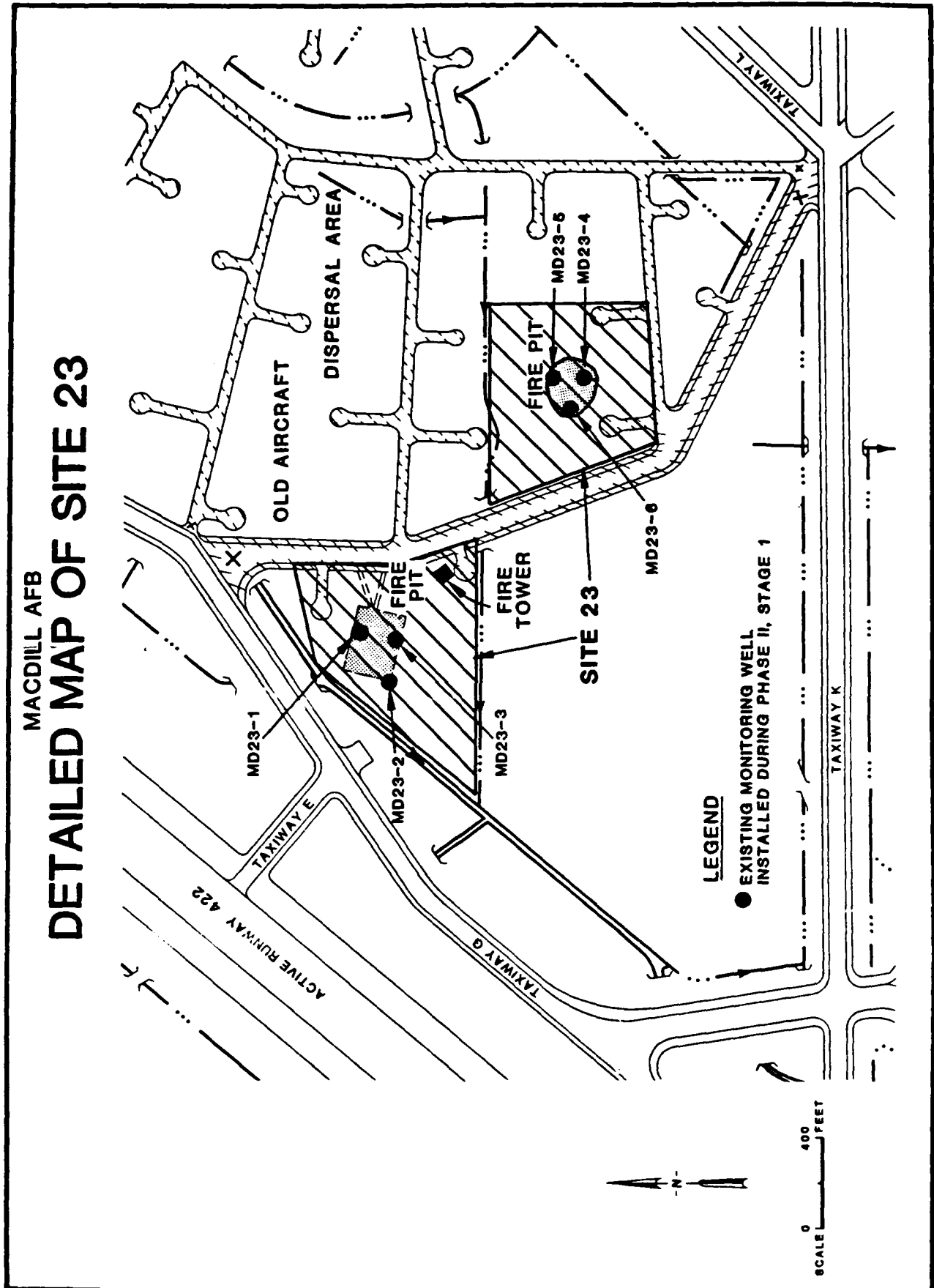
1.5.1.9 Site No. 23 - Fire Training Area

The Fire Training Area consists of two fire pits located in the middle portion of the base, along the western end of the old aircraft dispersal area (Figure 1.14). The two pits have been in existence since 1955, and training exercises have alternated between the two pits. The western pit, located near the small fire tower and Taxiway G, is currently being used for training exercises. The eastern pit is not currently in use.

Originally, fire training exercises included the burning of waste oils, fuels, and solvents that were stored at the sites in drums. These materials were dumped into pits and ignited, and the fires were extinguished using water and protein foams. Since 1974, only fuel with less than 10 percent contaminants has been used in fire training exercises.

FIGURE 1.13





Fuel was transferred to the sites, ignited, and the fires extinguished with water and Aqueous Film Forming Foam (AFFF).

This area was investigated under Phase II, Stage 1 through the installation and sampling of six shallow monitoring wells, three located at each burn pit. The analytical results indicate the presence of lead, volatile organics, fuels, and oil in the surficial aquifer (WAR, 1984). Lead was found in samples from well MD23-3 at 35 ug/L and in well MD23-6 at 38 ug/L. DOC levels were found at levels ranging from 13 to 328 mg/L. TOX levels were found at levels ranging from 810 to 5,900 ug/L as Cl. Samples from well MD23-3 showed benzene, trans-1,2- dichloroethene, 1,1,1-trichloroethane, trichloroethene, ethylbenzene, toluene, and xylenes at levels above detection limits. Samples from well MD23-6 showed bromoform, 1,1-dichloroethene, 1,1,1-trichloroethane, vinyl chloride, and ethylbenzene above detection limits.

1.5.2 Avon Park AFR

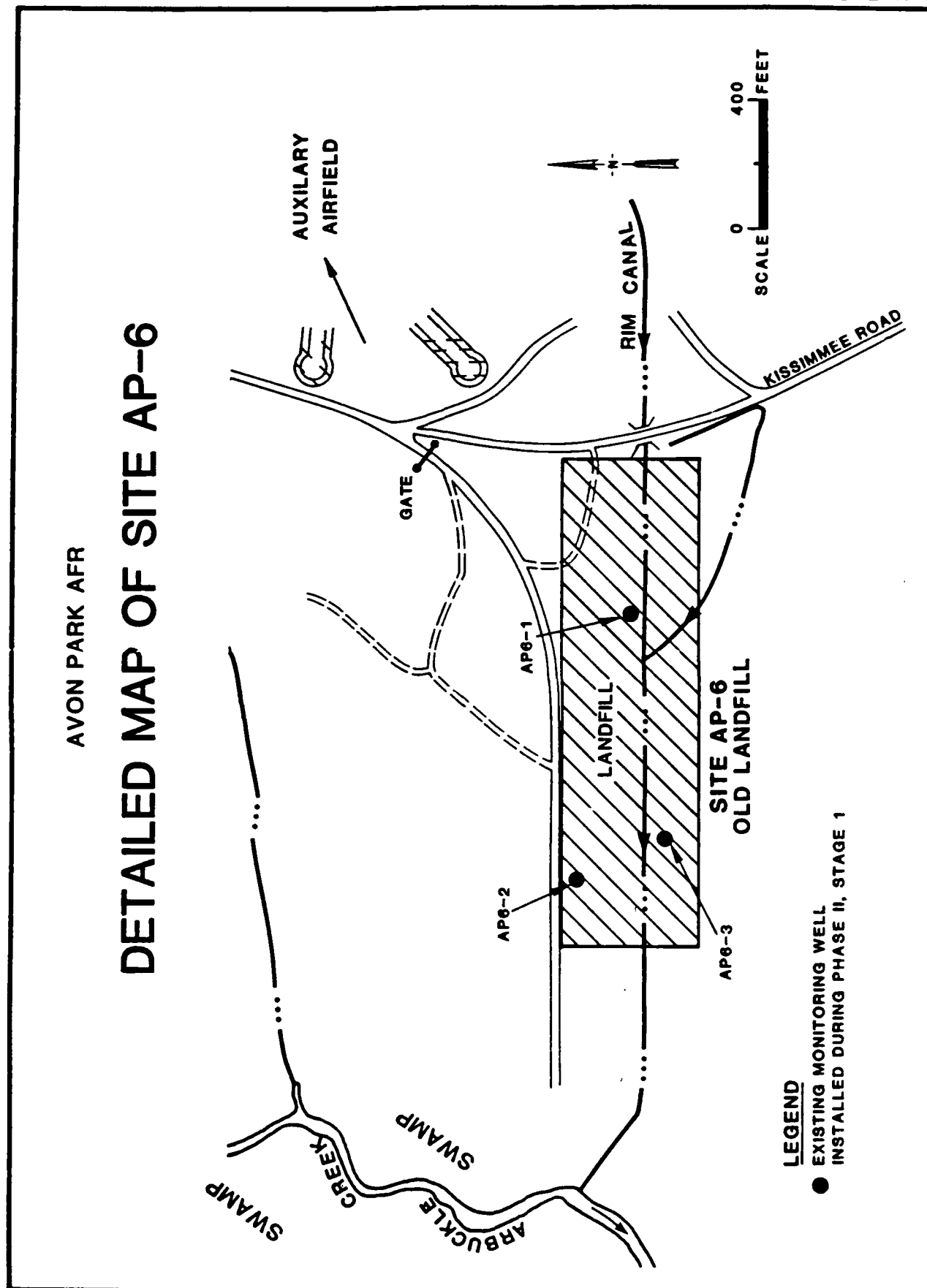
1.5.2.1 Site No. AP6 - Old Landfill

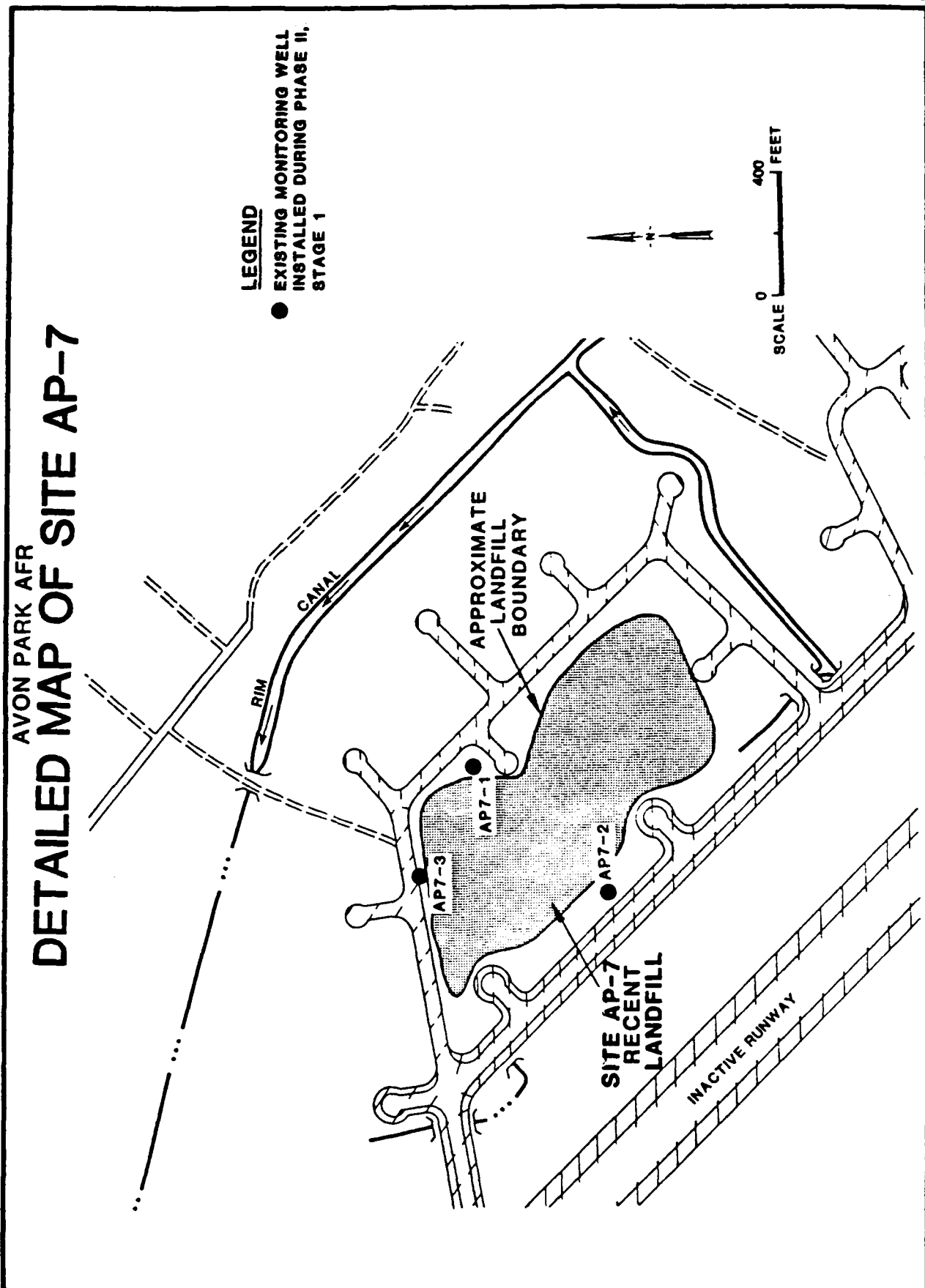
Site No. AP6 is an old sanitary landfill at the Avon Park AFR, located near the southwest end of the airfield (Figure 1.15). This landfill was used from about 1950 to 1978 for the disposal of general refuse, possibly including small quantities of hazardous materials. Phase II, Stage 1 work at this site included the installation and sampling of three shallow groundwater monitoring wells (Figure 1.15). Sampling indicated possible organic contamination of the surficial aquifer, based upon chemical analyses results (WAR, 1984). DOC levels ranged from 8 to 14 mg/L and TOX levels ranged from 110 to 120 ug/L as Cl. Lead was not found in any of the samples.

1.5.2.2 Site No. AP7 - Recent Landfill

Site No. AP7, referred to as the Current Landfill in the Phase II Stage 1 Report, was closed in 1985, just prior to the Phase II, Stage 2 study. For this report the site will be referred to as the "Recent Landfill, Site No. AP-7." The site is located in the northern portion of the auxiliary airfield near the closed runway and taxiways (Figure 1.16). This landfill was operated from 1978 to 1985 as a general refuse landfill, although small quantities of hazardous materials may also have been disposed of at this site.

Phase II, Stage 1 work at Site AP7 included the installation and sampling of three shallow monitoring wells (Figure 1.16). Analytical





results revealed possible organic contamination in the surficial aquifer (WAR, 1984). DOC was found at 17 mg/L and TOX was found at levels ranging from 40 to 100 ug/L as Cl.

1.5.2.3 Site No. AP9 - Army Test Site

Site No. AP9 was an area used for aerial dispersion testing using chemical and biological anticrop agents between 1951 and 1965. This site consists of the grassy areas between the runways and taxiways, and the area immediately east of the runways and taxiways at the auxiliary airfield (Figure 1.17). Residual levels of dioxin and herbicides are possible contaminants at this site, which was not previously investigated under either the Phase I or Phase II IRP efforts.

1.6 CONTAMINATION PROFILE

The field program, described in Section 3.0 of this report, involved the sampling of groundwater, surface water, sediments, and soils from nine sites at MacDill AFB and three sites at Avon Park AFR. These samples were analyzed for various contaminants suspected to be present at those sites because of past waste disposal practices or spills. These suspected contaminants were:

Suspected Contaminants at MacDill AFB

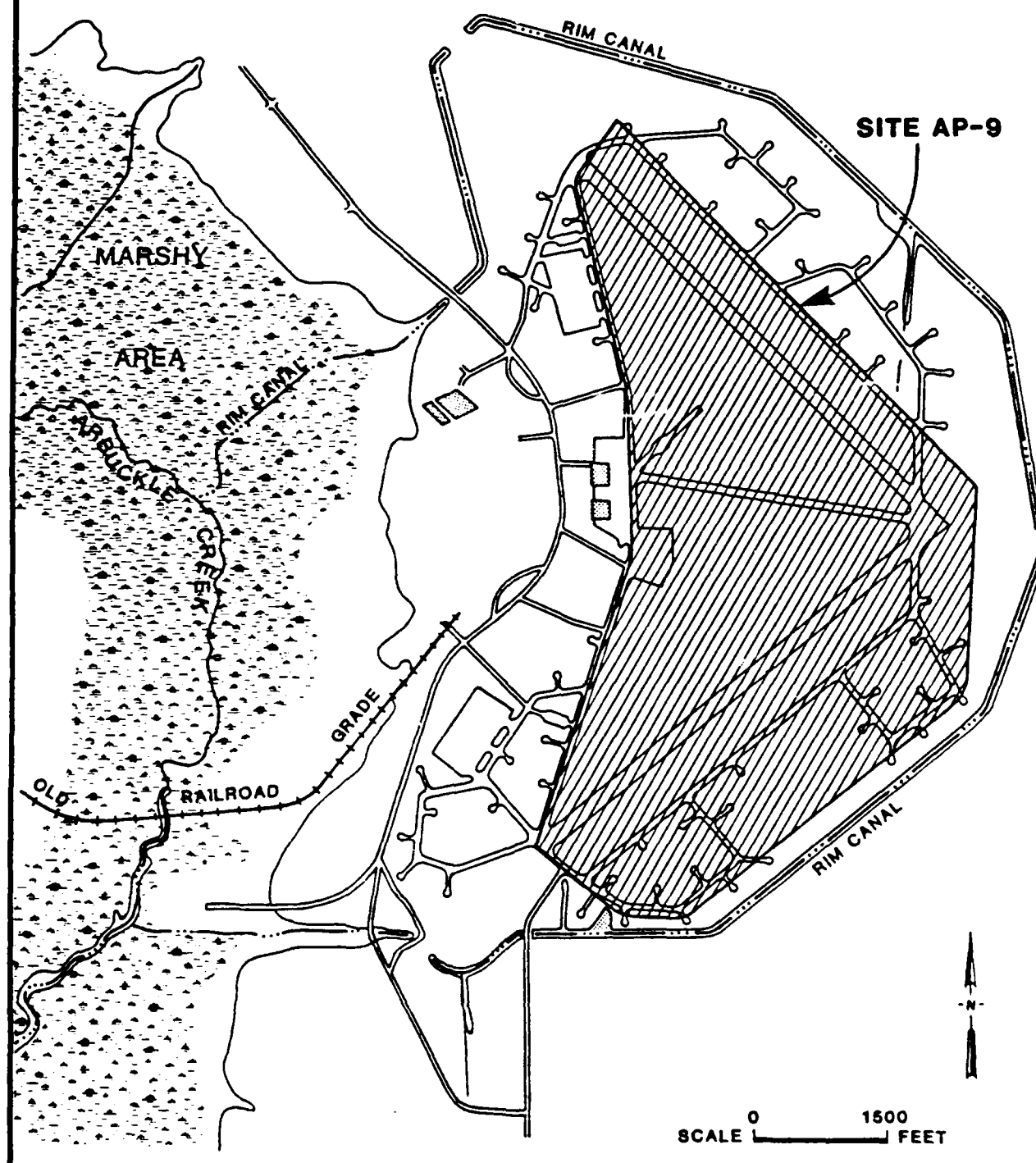
- o Volatile Halogenated Organics, including 1,2-Dibromoethane
- o Volatile Aromatic Organics
- o Base/Neutral and Acid Extractable Organics
- o Petroleum Hydrocarbons
- o Heavy Metals

Suspected Contaminants at Avon Park AFR

- o Volatile Halogenated Organics
- o Volatile Aromatic Organics
- o Base/Neutral and Acid Extractable Organics
- o Petroleum Hydrocarbons
- o Heavy Metals
- o Chlorinated Herbicides
- o 2,3,7,8-TCDD (Dioxin)

AVON PARK AFR

DETAILED MAP OF SITE AP-9



1.7 PROJECT TEAM

The Phase II, Stage 2 investigation at MacDill AFB and the Avon Park AFR was conducted by Engineering-Science (ES). The ES project team consisted of the following professionals:

Ernest J. Schroeder - B.S. in Civil Engineering, M.S. in Sanitary Engineering, with 20 years experience, served as Technical Director.

Mark A. Guthrie - B.S.E. in Civil Engineering, M.S.C.E. in Environmental Engineering, with 8 years experience, served as Project Manager.

Walker J. Duncan - B.S. in Geology, with 10 years experience, was the Project Leader.

Robert S. Mcleod - B.S., M.S. in Civil Engineering with 24 years experience, served as Technical Reviewer.

Duane R. Boline - B.S.E. in Physical Science, M.S. in Chemistry, Ph.D. in Analytical Chemistry, with 18 years experience, served as Quality Assurance Officer.

Craig L. Sprinkle - B.S. in Civil Engineering, B.A. in Geology, M.S. in Geochemistry with 13 years experience served as Geochemist and Hydrogeologist.

A. Scott Yankey - B.S., M.S. in Geology with 2 years experience, was the Project Geologist and Field Team Leader.

Edward L. Grunwald - B.S. in Bacteriology, M.S. in Public Health (Toxicology Specialization), with 8 years experience, was the project Health and Safety Officer.

Sharon A. Schultz - A.S. in Environmental Technology, with 7 years experience, was the Field Technician.

Resumes for these professionals are provided in Appendix C.

Diversified Drilling, Inc. of Tampa, Florida provided drilling and well construction subcontract services. Heidt and Associates, Inc. of Tampa, Florida provided surveying services. Laboratory analytical support was provided by Savannah Laboratories and Environmental Services, Inc. of Savannah, Georgia and Tallahassee, Florida.

1.8 FACTORS OF CONCERN

The major environmental and public health concerns at both MacDill AFB and Avon Park AFR are that spills or past waste disposal practices

may result in the contamination of ground and surface waters, and that migration of contamination off Air Force property could result in a potential threat to human health or the environment.

At MacDill AFB, the surficial aquifer is directly connected to surface water and may be connected to the deeper Floridan Aquifer, which is a major source of drinking water in the Tampa area and west-central Florida. Although the surficial aquifer is not used as a source of water supplies at MacDill AFB, and no water supply wells in either the surficial aquifer or Floridan Aquifer are known to exist on or near MacDill AFB, potential contamination of the groundwater system is a primary health concern.* The surficial aquifer is directly connected to the surface water system including drainage ditches, canals, and swampy areas. These surface waters are tidally influenced and drain through creeks and mangrove swamps into Tampa Bay and Hillsborough Bay. Of primary concern is whether contaminants may migrate into the surface waters and bays with adverse environmental effects.

At Avon Park AFR, the shallow groundwater is directly connected to surface waters and may also be connected to the deeper Floridan Aquifer System. The concerns at Avon Park AFR are essentially the same as at MacDill AFB. The Floridan Aquifer is the major source of drinking water supplies at Avon Park AFR and the surrounding area. Contaminants entering this system are a potential threat to human health. Contaminants entering the surface water system may migrate off base property and could also have adverse environmental effects.

* Conversations with personnel at USEPA and the Hillsborough County Health Department during December 1987 indicate that wells in the surficial or Floridan aquifers may exist and may still be used in the Port Tampa Area, north and west of MacDill AFB. These wells are probably not used for drinking water supplies but may be used for irrigation or other uses. The water is generally of poor quality with high iron and chloride content. City water services these areas but it is not certain whether any residences or businesses are still utilizing existing wells for any water uses.

SECTION 2
ENVIRONMENTAL SETTING

SECTION 2

ENVIRONMENTAL SETTING

The environmental settings of MacDill AFB and Avon Park AFB are described in this section with the primary emphasis on features that may affect the movement of contaminants off Air Force property. A summary of the environmental setting is presented at the end of this section.

2.1 MACDILL AFB

2.1.1 Location

MacDill AFB is located at the southern tip of the Interbay Peninsula in Hillsborough County, Florida. The base is bordered by the City of Tampa on the north, Hillsborough Bay on the east, and Tampa Bay on the west (Figure 2.1). MacDill AFB covers approximately 5,600 acres of land.

2.1.2 Climate

MacDill AFB and the surrounding vicinity has a humid, subtropical climate that is characterized by long, hot summers and short, mild winters. The annual average temperature at the base is 73°F with monthly averages ranging from a high of 83°F in August to a low of 61°F in January. Frost and freezing temperatures can be expected to occur at least once each year. The climate is moderated by the Gulf of Mexico which is responsible for mild winter temperatures and high relative humidities.

The rainy season at MacDill AFB occurs from May through September and the dry season occurs during fall and winter. Annual rainfall averages approximately 44 inches with the lowest rainfall in April and highest rainfall in August (Table 2.1). Heavy thunderstorms are common during summer months, accounting for high rainfall averages during the summer season. Average annual evapotranspiration is approximately 39 inches and average annual lake evaporation is approximately 51 inches (Fernald and Patton, 1984).

FIGURE 2.1

MACDILL AFB AREA LOCATION MAP

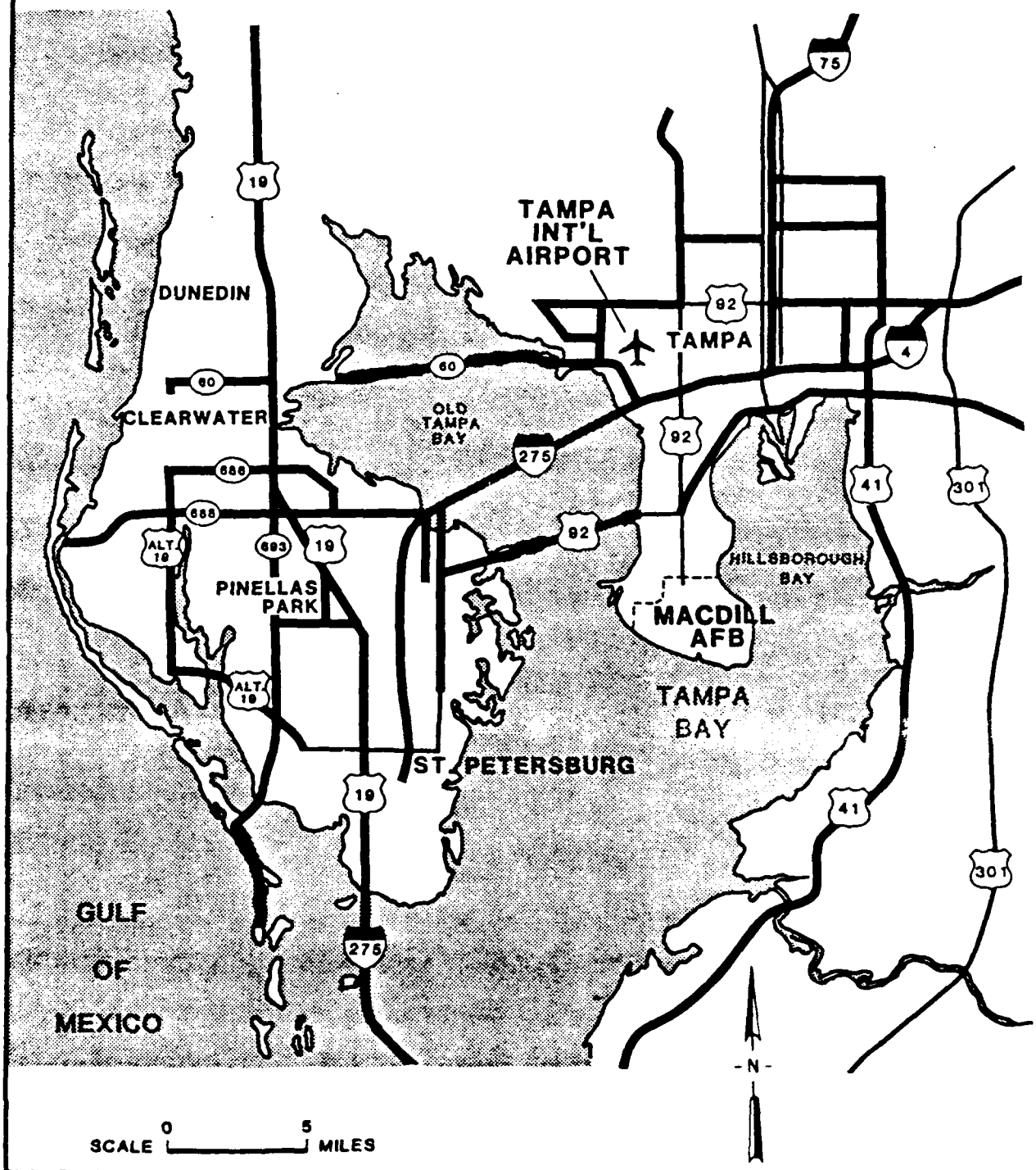


TABLE 2.1
METEOROLOGICAL DATA FOR MACDILL AFB

Parameter	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Temperature (°F)													
Average Daily Max.	70	71	75	81	86	89	89	90	89	84	76	71	81
Average Daily Min.	52	54	59	64	70	74	75	76	75	68	59	54	65
Normal	61	62.5	67	72.5	78	81.5	82	83	82	76	67.5	62.5	73
Precipitation (inches)													
Normal	2.27	2.94	2.99	1.60	3.10	4.86	7.05	7.21	5.72	2.49	1.66	2.39	44.28

Source: MacDill AFB, USAFETAC, Tab D. 4 April 1980.

Period of Record: 1949-1980

2.1.3 Topography And Physiography

MacDill AFB is located within the Gulf Coastal Lowlands of the Gulf Coastal Plain Province (Figure 2.2). This region is characterized by flat topography with numerous wetlands. Sinkholes are also found in this area. Elevations are generally less than 50 feet above mean sea level (msl).

MacDill AFB itself is characterized by flat topography with elevations of 15 feet msl or less. Much of the base is less than 5 feet msl and is covered by mangrove swamp.

2.1.4 Surface Water Hydrology

MacDill AFB is located at the southern tip of the Interbay Peninsula within an ill defined lowland area. The Interbay Peninsula is generally drained by small shallow streams into Hillsborough Bay or Tampa Bay. Stormdrains, canals, and drainage ditches drain water from streets and paved areas. Runoff rates are low and standing water and wetlands are common due to low relief.

Surface water hydrology on MacDill AFB is characterized by low, flat areas with low runoff rates and standing water areas (wetlands). Drainage canals, storm drains, and tidal creeks drain the base into Tampa Bay and Hillsborough Bay. Surface water runoff from precipitation is controlled by a stormwater canal system which carries water to tidal creeks or directly to Tampa Bay or Hillsborough Bay (Figure 2.3). Tidal streams and mangrove swamps cover a large portion of the south base area. Broad Creek and Coon Hammock Creek are the two main outlets in the mangrove area.

2.1.5 Geology

2.1.5.1 Regional Geology

Central Florida and MacDill AFB lie within the Atlantic Coastal Plain Geologic Province. The Coastal Plain is characterized by thick unconsolidated to consolidated sediments forming a wedge that thins inland and generally overlies crystalline bedrock. In Central Florida (Figure 2.4), the Coastal Plain sediments found at the surface are Miocene or younger rocks and consist of clastic sediments and some sandy limestones and dolomites. Miocene formations in Central Florida consist

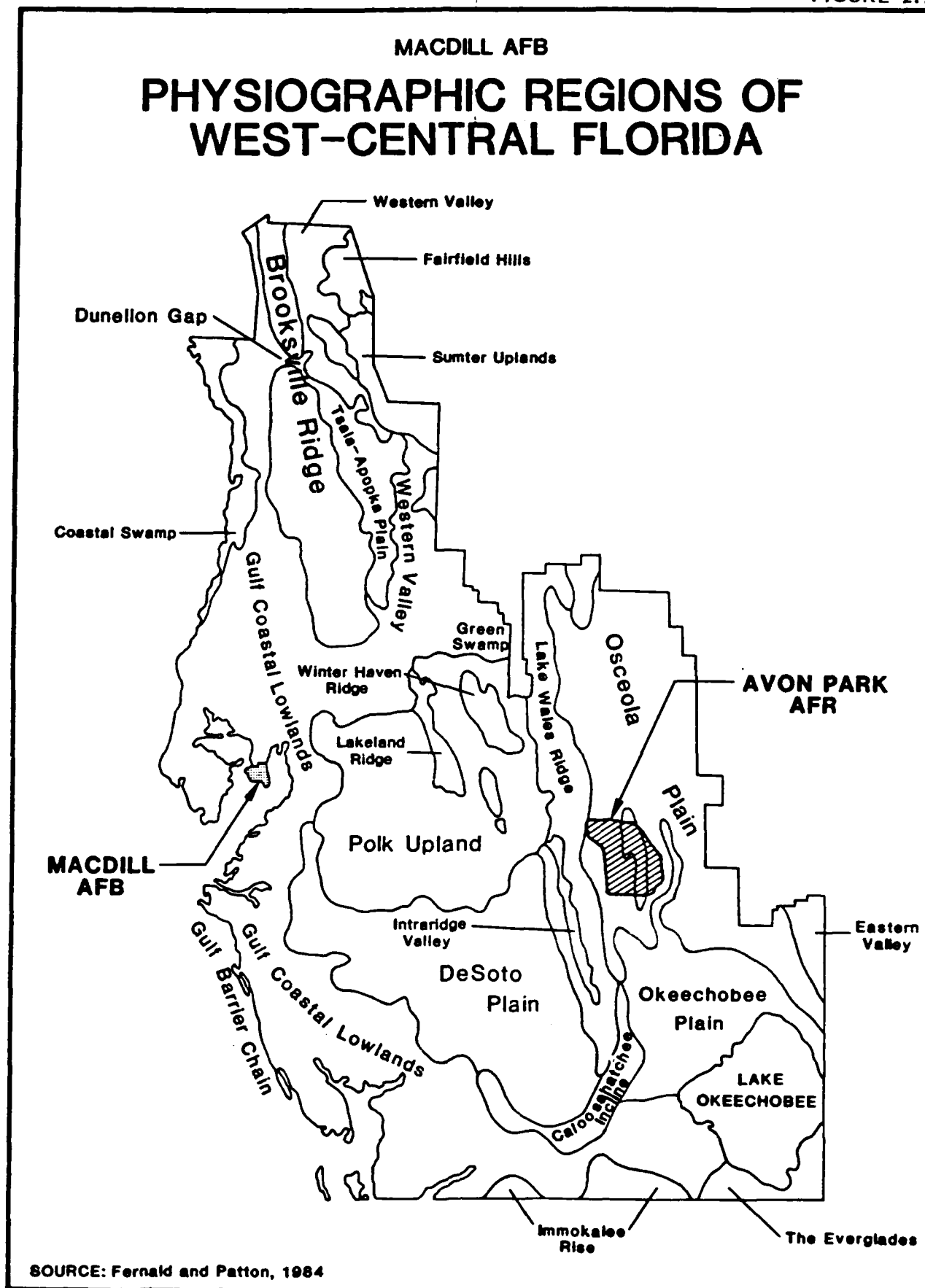
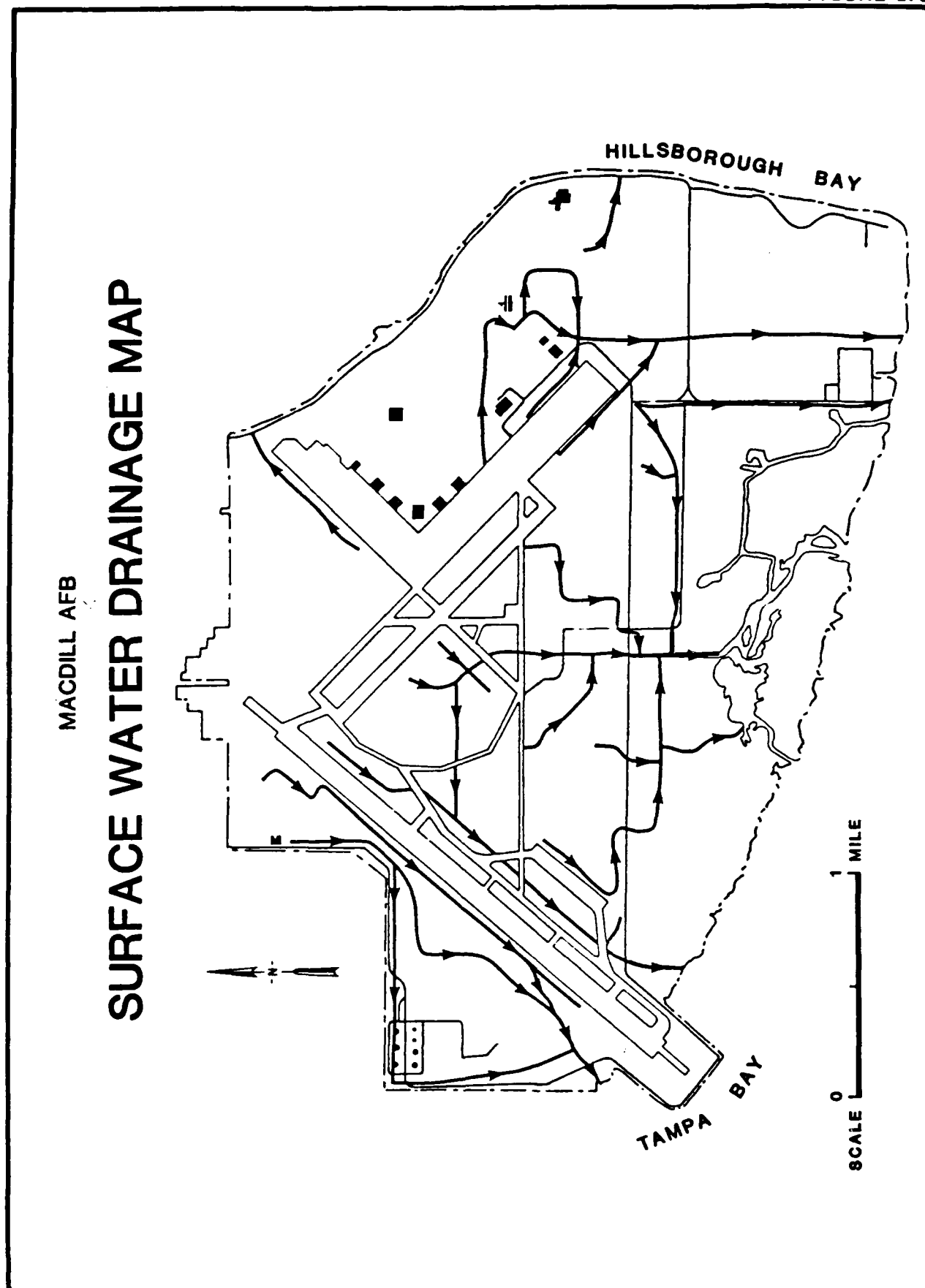
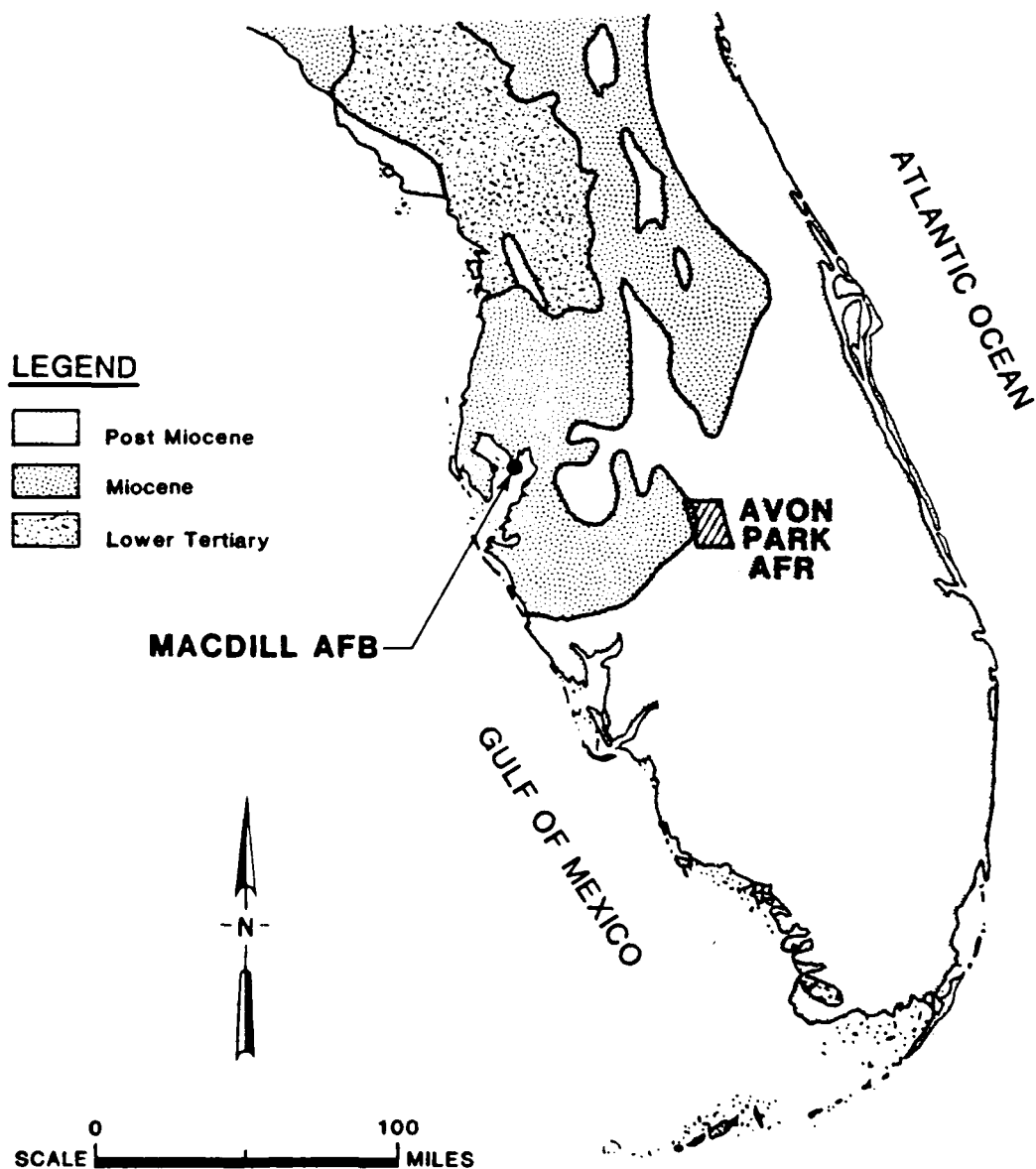


FIGURE 2.3



MACDILL AFB

GENERALIZED GEOLOGIC MAP OF CENTRAL FLORIDA INCLUDING THE MACDILL AFB AREA



SOURCE: MMer, 1984

of the Hawthorn Formation and the Tampa Limestone. These units are usually highly dissected and contain phosphatic and siliceous sediments. The Oligocene-aged Suwannee Limestone, and the Eocene-aged Ocala Limestone and Avon Park Formations underlie these Miocene sediments. The general stratigraphy for the Tampa area is shown in Figure 2.5 and described below. Figures 2.6, 2.7, and 2.8 show the general geology of the west-central Florida region near Tampa and MacDill AFB.

The Hawthorn Formation is a complexly interbedded, highly variable sequence that contains clays, silts, and sand beds with scarce to abundant phosphate. Phosphatic dolomite or dolomitic limestones are common in the lower part of the formation. The Hawthorn Formation generally consists of a basal calareous unit, a middle clastic unit, and a highly variable, mixed clastic and carbonate upper unit. The entire formation constitutes a low-permeability rock unit which, when present, comprises the upper confining unit of the Floridan Aquifer System (Miller, 1986).

The Tampa Limestone is the basal unit of the Miocene-aged sediments. It is generally a white to light-gray, sandy, hard to soft, locally clayey, fossiliferous limestone that may contain phosphate and chert. The Tampa Limestone grades into a white, hard to semi-indurated, finely crystalline to micritic limestone with sand and clay. The Tampa-Suwannee contact is gradational over most of this area.

The Suwannee Limestone is generally a white to cream, finely pelletal limestone to a sandy limestone. In places part of the Suwannee Limestone is complexly interbedded with a crystalline, highly vuggy, fossiliferous limestone. The Suwannee Limestone overlies the Eocene-aged Ocala Limestone.

The Ocala Limestone is one of the most permeable rock units in the Floridan Aquifer System and consists of an upper and lower part. The upper part of the Ocala is generally a soft, white, porous coquina. The lower part of the Ocala consists of cream to white, fine grained, soft to semi-indurated, micritic limestone containing fossils. The lower part is not present everywhere and may be locally dolomitized. In parts of southern Florida the entire Ocala may be micritic to pelletal limestone. Where the Ocala is near the surface it results in the dissolution of the limestone and the development of sinkholes and karst topography. The Ocala Limestone overlies the Avon Park Formation.

MACDILL AFB - AVON PARK AFR

GENERALIZED STRATIGRAPHY FOR WEST-CENTRAL FLORIDA

System	Series	Stratigraphic unit	General lithology	Major lithologic unit	Hydrogeologic unit
Quaternary	Holocene and Pleistocene	Surficial sand, terrace sand, phosphorite	Predominantly fine sand; interbedded clay, marl, shell, limestone, phosphorite	Sand	Surficial aquifer
		Undifferentiated deposits ¹	Clayey and pebbly sand; clay, marl, shell, phosphatic	Clastic	Confining bed
Tertiary	Pliocene				INTERMEDIATE
	Miocene	Hawthorn Formation	Dolomite, sand, clay, and limestone; silty, phosphatic	Carbonate and clastic	Aquifer
		Tampa Limestone	Limestone, sandy, phosphatic, fossiliferous; sand and clay in lower part in some areas		CONFINING BEDS
	Oligocene	Suwannee Limestone	Limestone, sandy limestone, fossiliferous	Carbonate	FLORIDAN AQUIFER SYSTEM
	Eocene	Ocala Limestone	Limestone, chalky, foraminiferal, dolomitic near bottom		
		Avon Park Limestone	Limestone and hard brown dolomite; intergranular evaporite in lower part in some areas		Upper Floridan aquifer
		Lake City Limestone and Oldsmar Limestone	Dolomite and limestone, with intergranular gypsum in most areas		Middle confining unit
	Paleocene	Cedar Keys Limestone	Dolomite and limestone with beds of anhydrite	Carbonate with evaporites	Lower Floridan aquifer
					Lower confining unit

¹Includes all or parts of Caloosahatchee Marl, Bone Valley Formation, Alachua Formation, and Tamiami Formation.

SOURCE: Ryder, 1985.

FIGURE 2.6

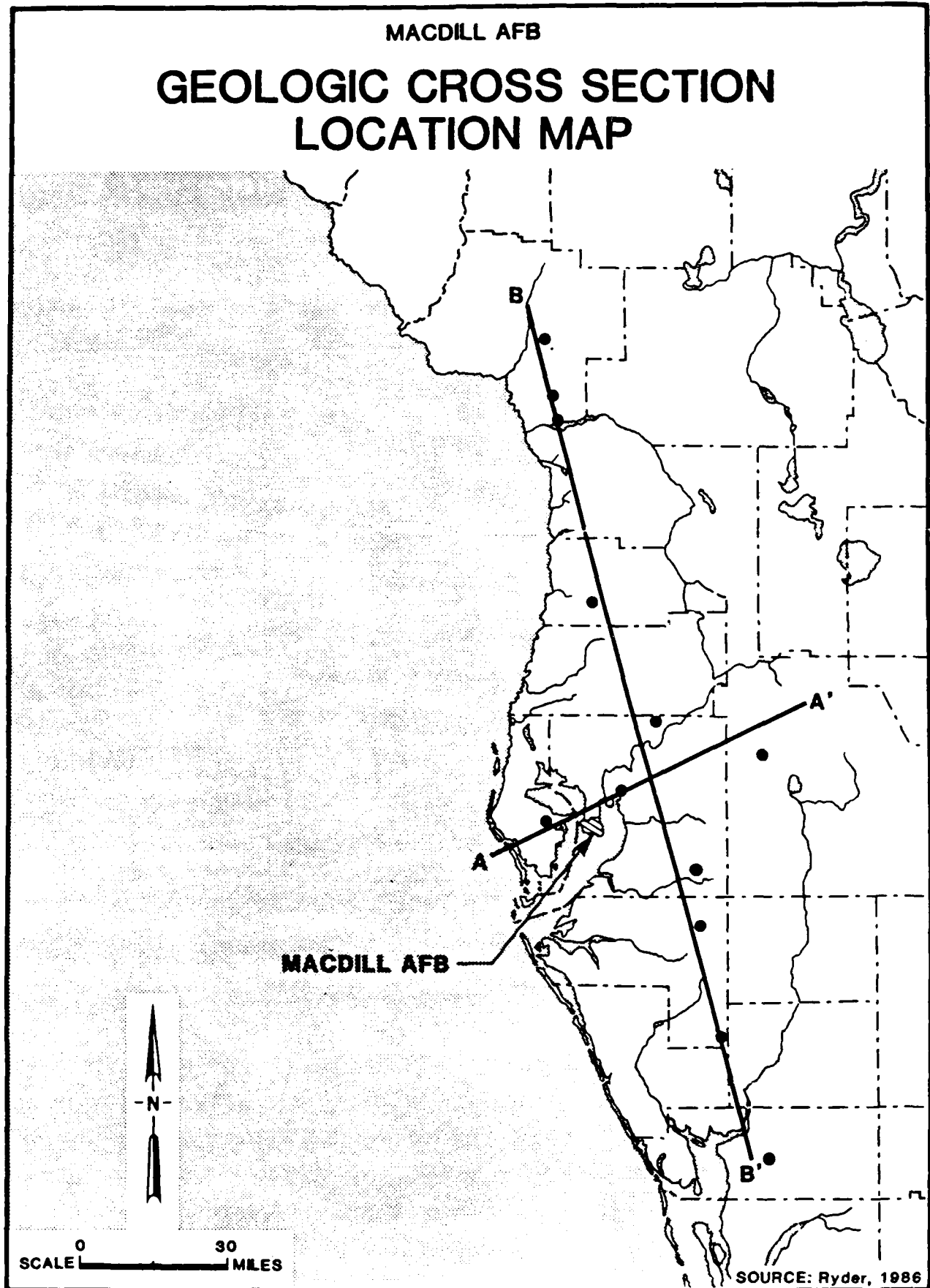


FIGURE 2.7

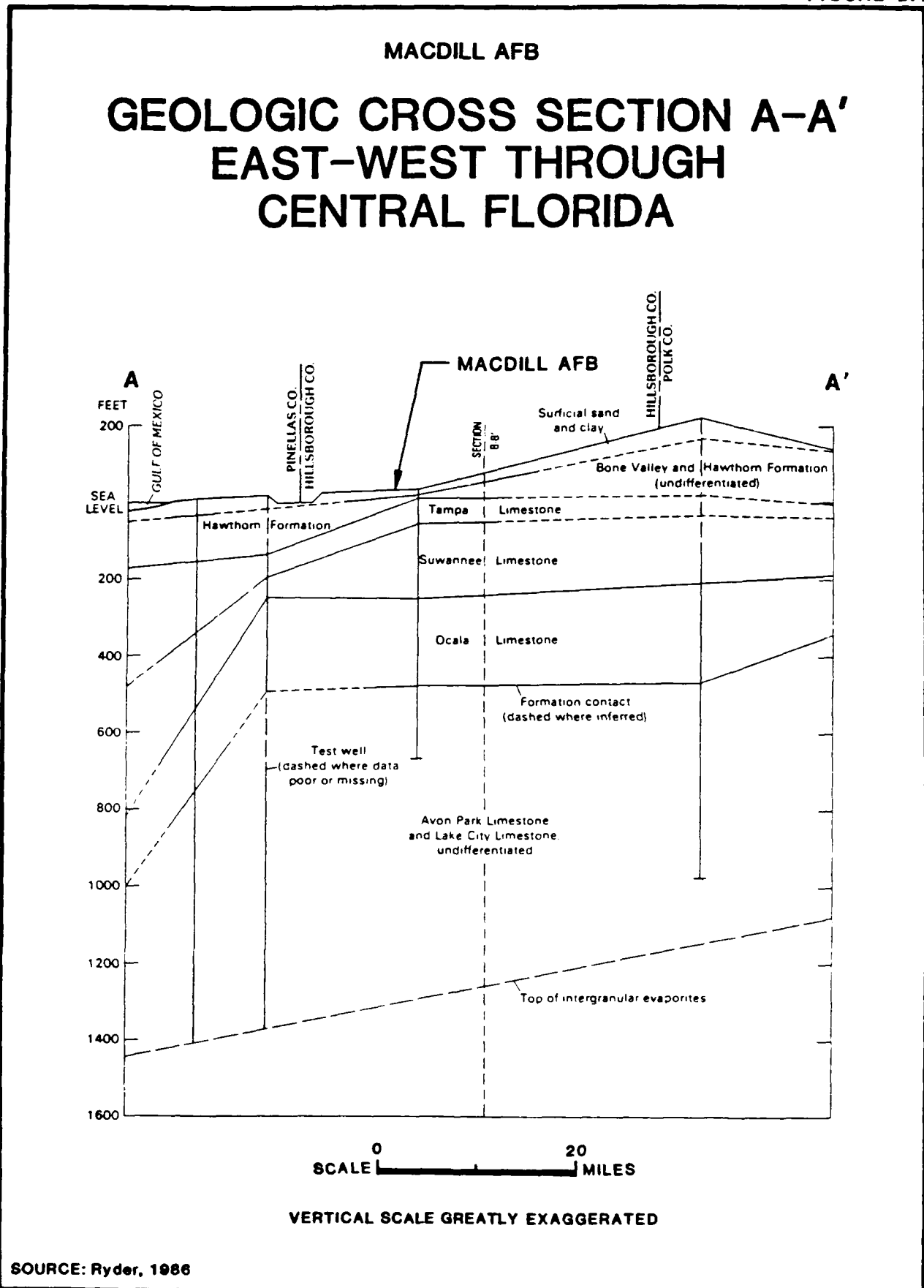
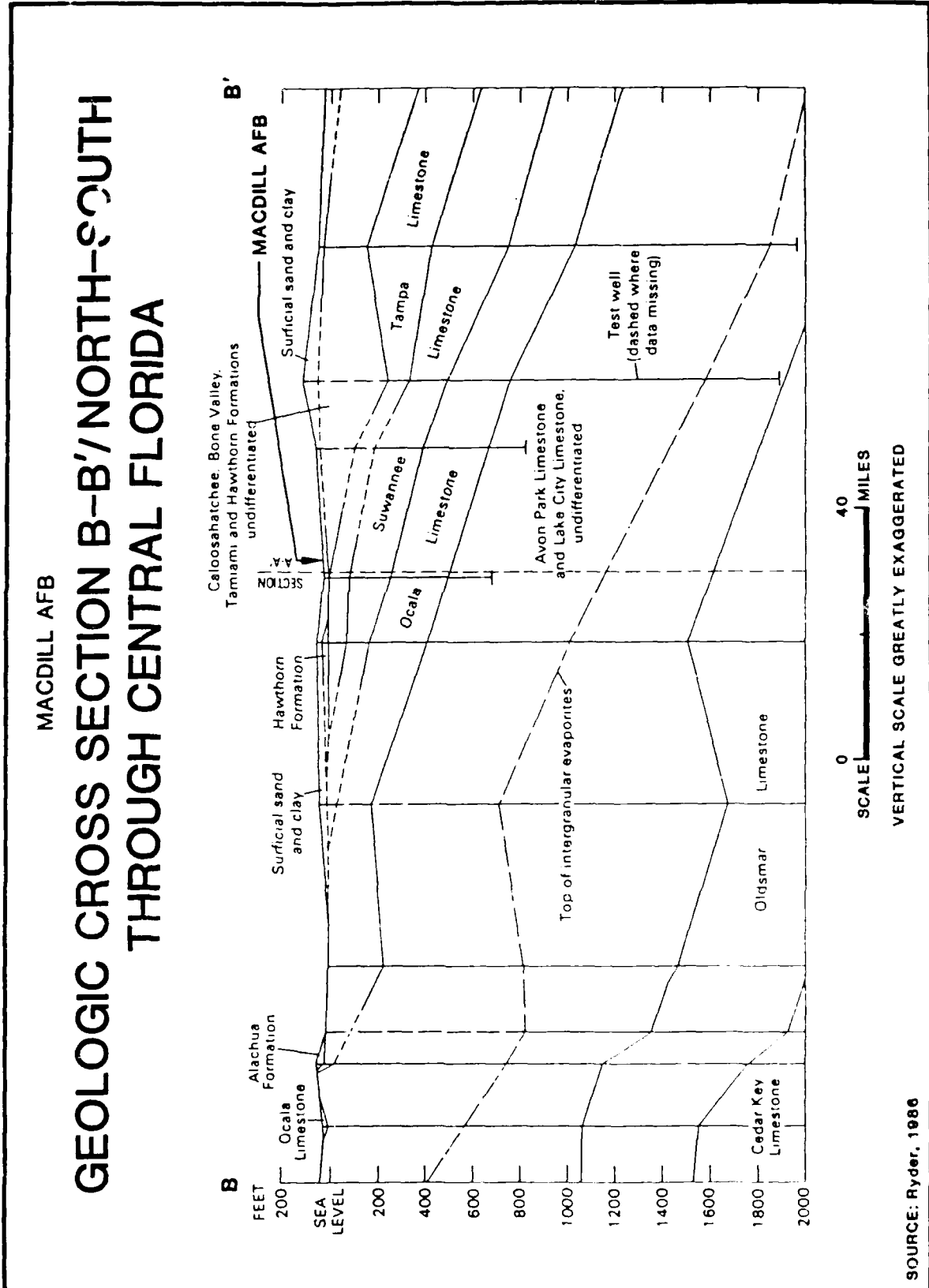


FIGURE 2.8



The Avon Park Formation is a sequence of predominantly brown limestones and dolomites of various textures that underlies the Ocala Limestone. The limestones are generally cream, tan, or light brown, soft to well-indurated, mostly pelletal but locally micritic. The dolomites are generally cream to light or dark brown, fine to medium crystalline, slightly vuggy, and sometimes fractured. The lower part of the Avon Park Formation in west-central Florida consists of low permeability gypsiferous limestone and dolomite and forms an important subregional confining unit within the Floridan Aquifer System (Miller, 1986). Rocks of older age underlie the Avon Park formation. These units were not investigated for this study.

Surface deposits in the Tampa area generally consist of sands, clays and gravels that are of fluvial origin, including beach and dune deposits, stream sediments, and lagoonal and estuarine deposits. They are generally highly permeable and may provide recharge to the Floridan Aquifer System in areas where they directly overlie the upper units of the aquifer.

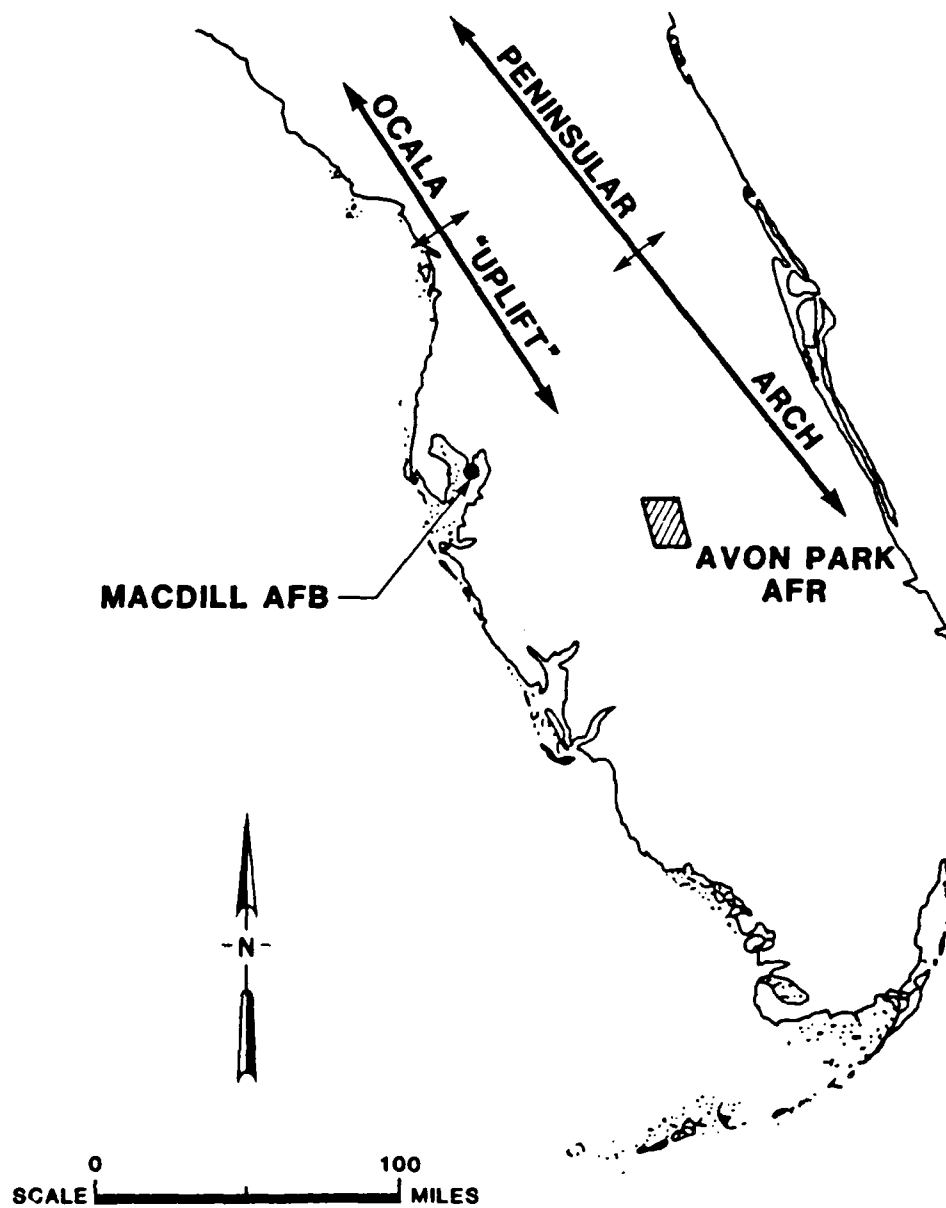
The general configuration of the Coastal Plain sediments in the central Florida region is that of a tilted wedge that thickens seaward. Superimposed on this thick mass of unconsolidated to semiconsolidated sediments are gentle uplifts and depressions of subregional extent. The dominant structural features of this region are the Peninsular Arch and the Ocala "Uplift" (Figure 2.9). The Peninsular Arch is a northwest trending feature that was positive (or upwarped) from Jurassic through Cretaceous times and intermittently positive through Cenozoic time. The Ocala "Uplift" is not a true uplift but was probably caused by differential compaction of materials following deposition. Both features appear as areas where sediments thicken on either flank of the structures.

2.1.5.2 Local Geology

The surficial deposits at MacDill AFB consist of thin layers of sand and clay which overlie the Tampa Limestone. These materials may or may not be remnants of the Hawthorn Formation which is thin to absent at MacDill AFB. The sands are generally quartzitic, very fine to fine grained. They grade vertically downward into sandy clays, silty clays,

MACDILL AFB - AVON PARK AFR

STRUCTURAL FEATURES OF CENTRAL FLORIDA



SOURCE: Miller, 1984

and clays. These clayey materials overlies the top of the Tampa Limestone which has an irregular surface of solution cavities and voids. The Tampa Limestone is the upper-most unit of the Floridan Aquifer System in this area. Figures 2.10, 2.11, 2.12, 2.13, and 2.14 show the geology and strata encountered during well installation at MacDill AFB. The sands were five to twenty feet thick and the clay layers were generally two feet to twenty feet thick in boreholes drilled on the base, though clay was not present in every boring. Below the clay, a layer of broken shell and marl was encountered in some borings while a hard white limestone was encountered in the bottom of other borings. The surface of this limestone unit, the Tampa Limestone, is irregular with voids and cavities. These cavities are usually filled with soft clayey materials and clastic detritus.

2.1.6 Hydrogeology

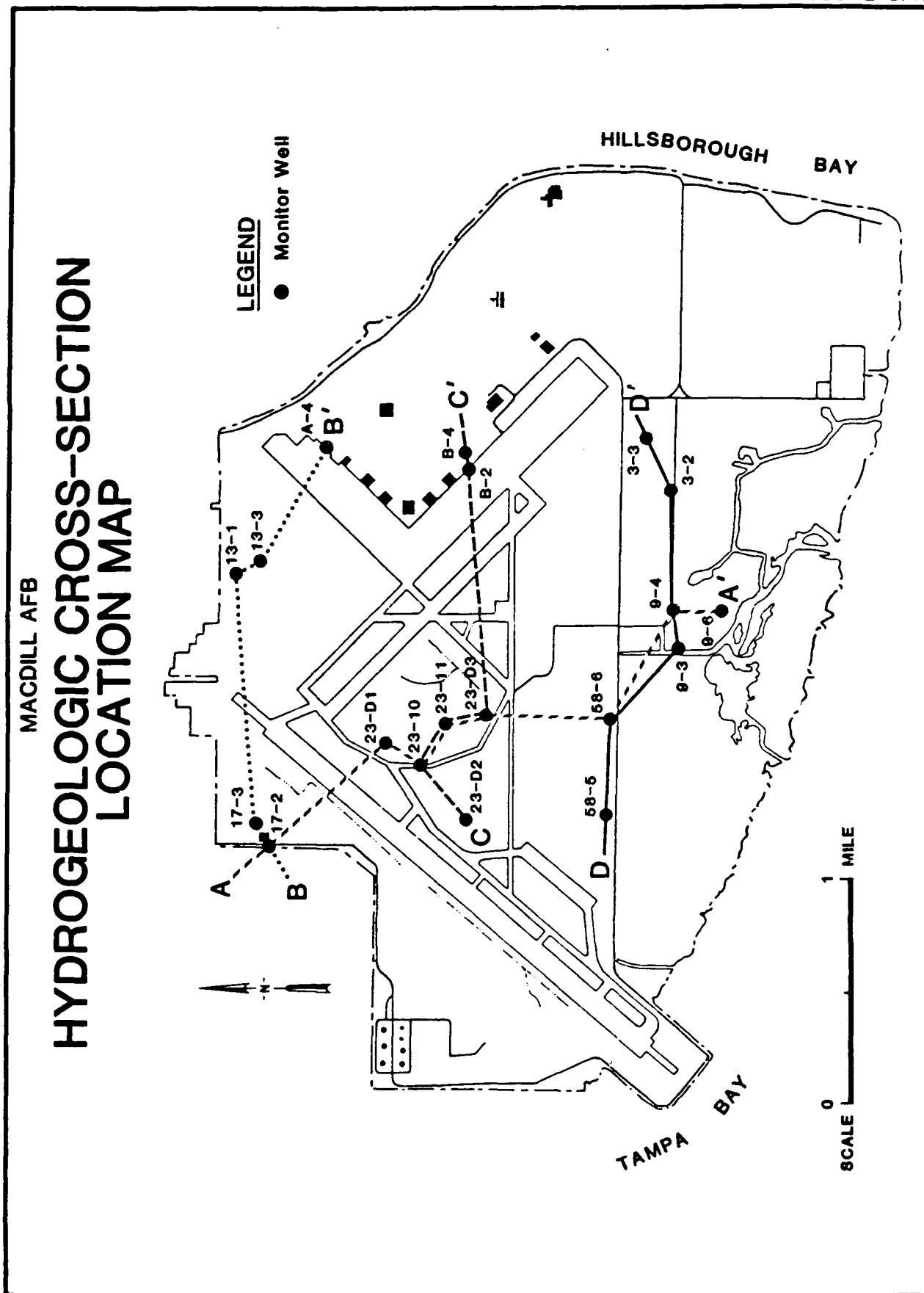
2.1.6.1 Regional Hydrogeology

The regional hydrogeology of the west-central Florida area is characterized as a multilayered aquifer system which includes a surficial aquifer and the confined Floridan Aquifer. The surficial aquifer consists of sand, clayey sand, shell, and marl. These deposits range in thickness from almost zero to approximately 100 feet. The water table in this aquifer is within a few feet of the surface in some areas.

In some parts of west-central Florida an intermediate aquifer system exists below the surficial aquifer and above the Upper Floridan Aquifer. This intermediate aquifer system consists of: a lower confining unit of relatively impermeable clayey materials which lies directly upon the top of the Upper Floridan Aquifer; the aquifer which consists primarily of carbonate rocks within the Hawthorn Formation and sometimes within the top of the Tampa Limestone; and, a nearly impermeable confining layer which consists of clayey surficial deposits or clayey materials of the upper Hawthorn Formation which overlies the carbonate rock unit. This system ranges in thickness from less than 25 feet to about 400 feet, and transmissivities in the system range from nearly zero to about 1,000 ft²/day.

The Floridan Aquifer consists of an upper aquifer and a lower aquifer. The upper system consists of several permeable carbonate

FIGURE 2.10



MACDILL AFB HYDROGEOLOGIC CROSS-SECTION A-A'

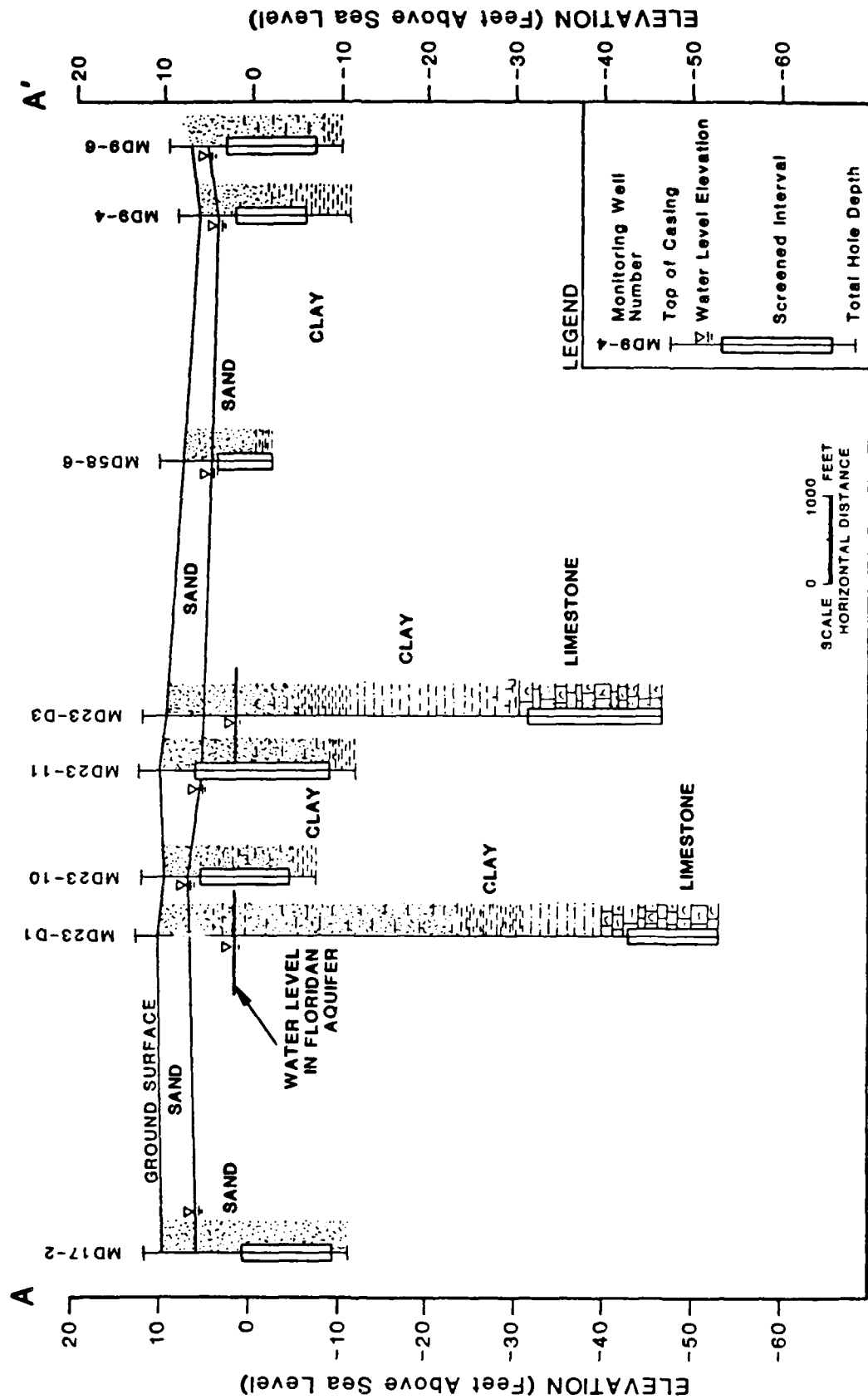


FIGURE 2.11

MACDILL AFB

HYDROGEOLOGICAL CROSS-SECTION B-B'

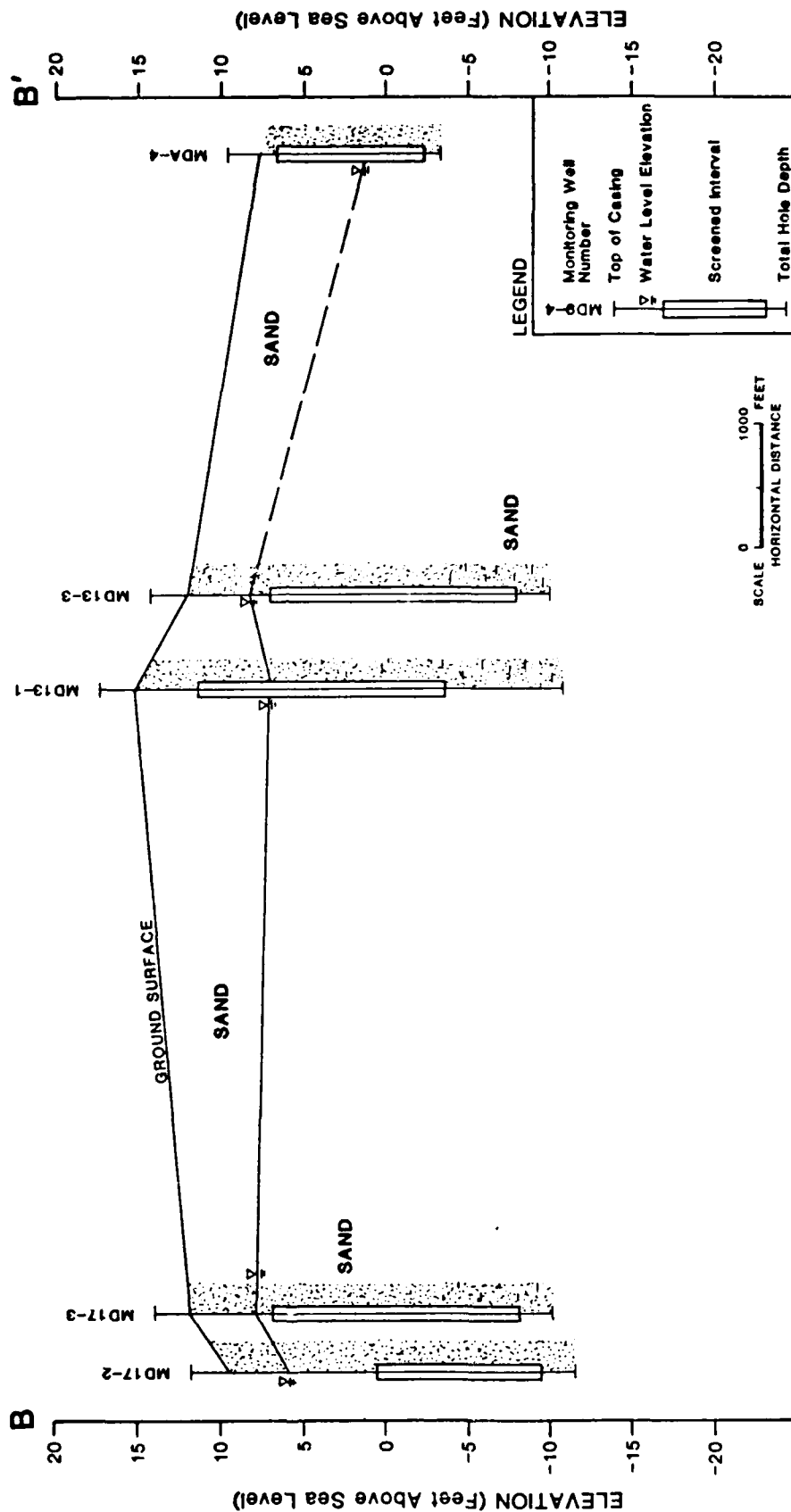
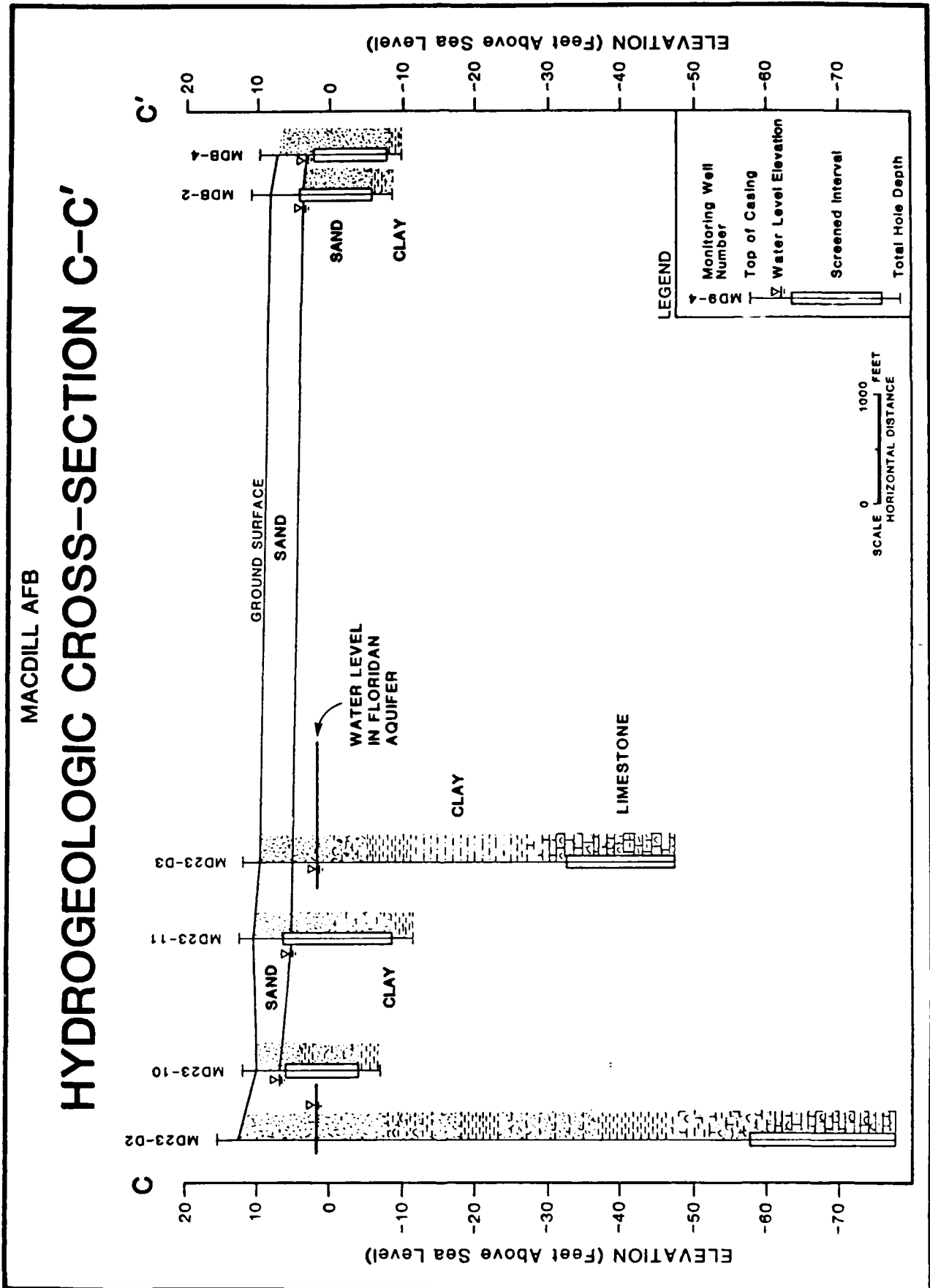


FIGURE 2.12

FIGURE 2.13



MACDILL AFB

HYDROGEOLOGIC CROSS-SECTION D-D'

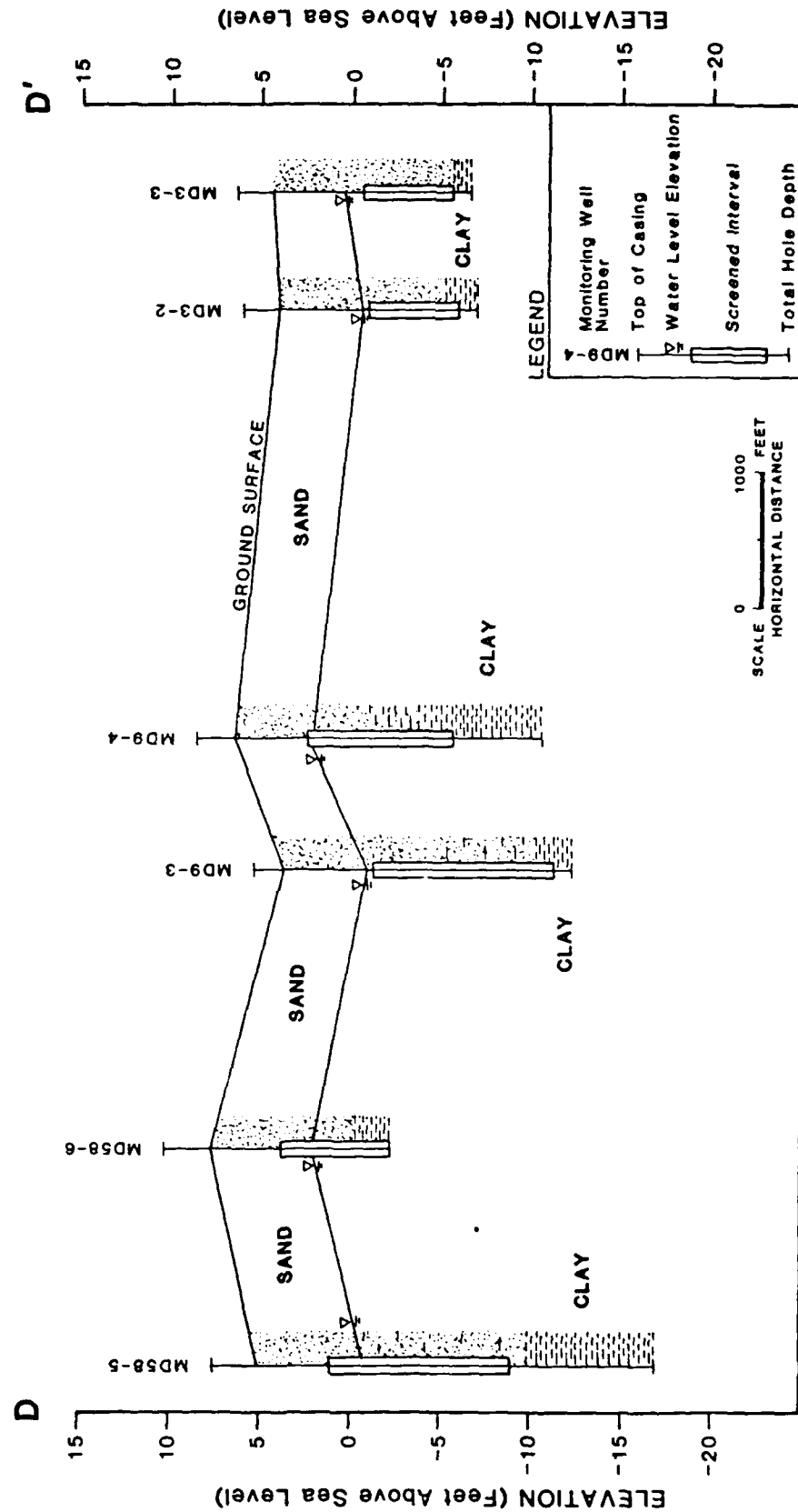


FIGURE 2.14

formations which are (from top to bottom) the Tampa Limestone, Suwannee Limestone, Ocala Limestone, and the upper part of the Avon Park Formation. These carbonate formations consist of sequences of highly permeable limestones, sandy limestones, and dolomites which range in thickness from about 500 feet to over 1,800 feet. The transmissivity of the Upper Floridan is known to exceed 1,000,000 ft²/day in the vicinity of high-yielding springs. The base of the Upper Floridan Aquifer is the highly impermeable, intergranular evaporites of the Avon Park Formation which separates the Upper Floridan from the Lower Floridan Aquifer. The Lower Floridan was not investigated for this report.

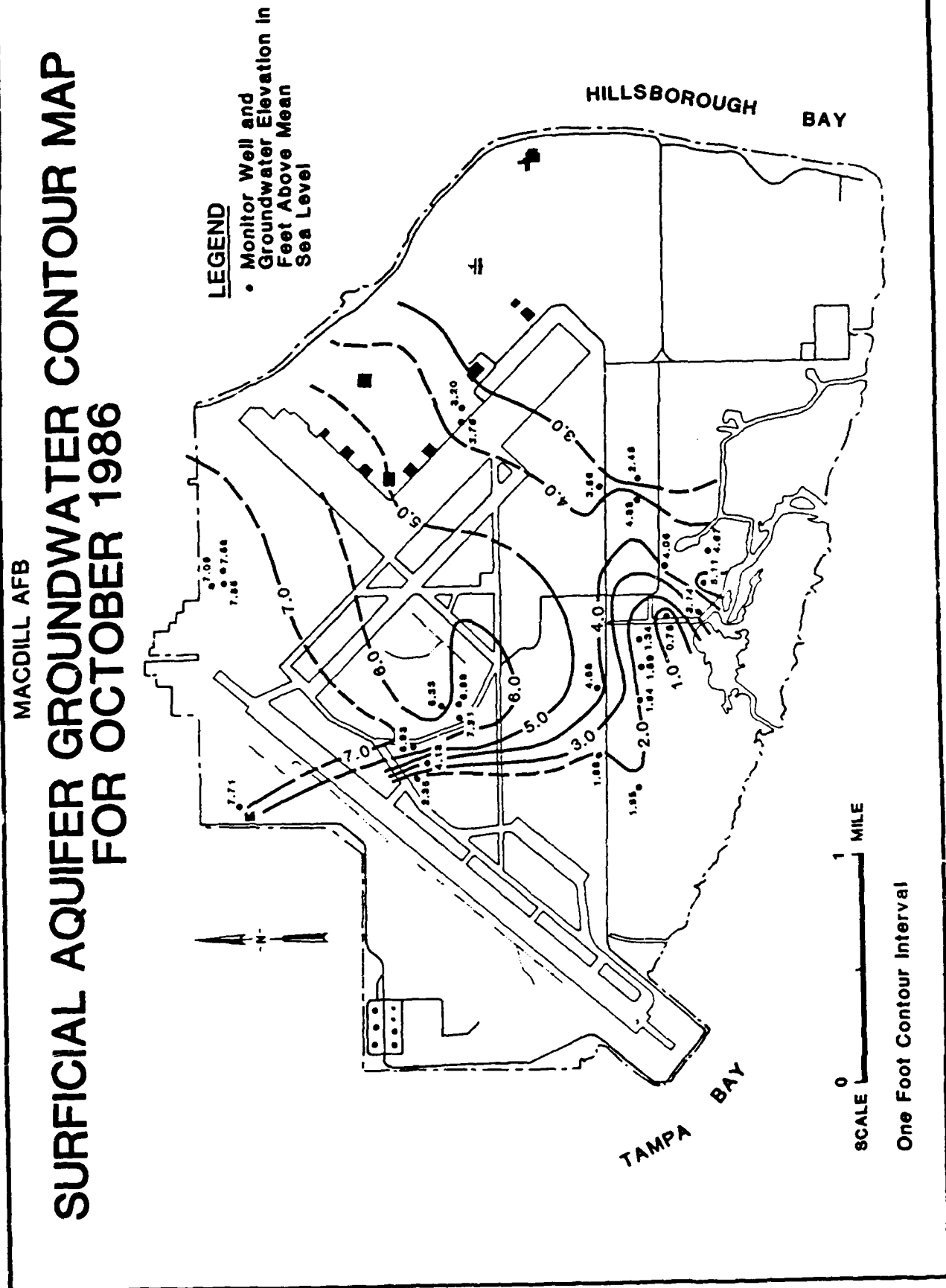
Recharge rates to the Floridan Aquifer are high in the northern portions of the region where the aquifer outcrops or is in direct contact with the surficial aquifer. Recharge is low to non-existent in the south. In the Tampa area recharge is low to moderate. Near the coast, the aquifer contains water high in chlorides due to salt water intrusion (Ryder, 1985).

2.1.6.2 Local Hydrogeology

Groundwater at MacDill AFB occurs in the shallow, surficial aquifer under water-table conditions and in the Floridan Aquifer under confined conditions. The surficial aquifer at MacDill AFB consists of fine to very fine sands and clayey sands which are from five to twenty feet thick. The water table in these materials is shallow, often as high as three feet below ground surface. Groundwater levels and flow directions are generally determined by low gradients and are tidally influenced by drainage ditches and canals and Hillsborough and Tampa Bays. Groundwater levels in this aquifer also vary seasonally with rainfall amounts. Recharge to the surficial aquifer is from direct infiltration of precipitation. Figures 2.10 to 2.14 show groundwater levels and gradients across sites and between sites at MacDill AFB. Figure 2.15 shows generalized water level contours and flow directions for the surficial aquifer during October, 1986 at MacDill AFB.

The Upper Floridan Aquifer underlies the surficial aquifer at MacDill AFB. The Tampa Limestone forms an irregular surface beneath the surficial aquifer. During October 1986, water in the Upper Floridan stood at approximately two feet msl in three wells completed in the Tampa Limestone.

FIGURE 2.15



The surficial aquifer and the Floridan Aquifer may be hydraulically connected in some areas beneath MacDill AFB. The clayey confining layer that separates the two aquifers was observed to vary between two and twenty feet in the boreholes drilled at MacDill AFB but may be absent in other areas at the base. Recharge from the surficial aquifer to the Upper Floridan Aquifer may take place in areas where the clay layer is thin or absent. Generally, however, recharge to the Floridan Aquifer is very low in this area due to the presence of the confining layer.

Water quality in the Floridan Aquifer in the Tampa area is affected by salt water intrusion. Past overpumping of the aquifer in the Tampa-St. Petersburg area pulled saltwater into the Floridan Aquifer. Well fields west of MacDill AFB which served the City of St. Petersburg and Pinellas County have been closed due to salt water intrusion. A thin layer of fresh water generally overlies the brackish water in the upper part of the Tampa Limestone. The water quality of the surficial aquifer is generally considered to be good except in areas near the coast where saltwater intrusion is common. Water from the monitoring wells installed at MacDill AFB generally showed high conductivities which may be caused by tidal influences.

The surficial aquifer is not used for water supplies either on or near MacDill AFB, and no wells drawing water from the surficial aquifer exist on the base. However, recent information from the Hillsborough County Health Department indicates that wells in the surficial aquifer and the Floridan Aquifer may still be in use in the Port Tampa area (Norman Vik, Hillsborough County Health Department, December 1987). The Floridan Aquifer, although not used for water supplies at MacDill AFB, is a major source of water in west-central Florida and the Tampa area. Large well fields exist north of Tampa which supply water to municipalities and industries. Water supply for MacDill AFB is provided from the Hillsborough River by the city of Tampa, Florida.

2.1.7 Summary of Environmental Setting at MacDill AFB

The principal environmental conditions that could affect movement of contaminants at MacDill AFB are summarized as follows:

- o Average annual precipitation is approximately 44 inches, and average annual evapotranspiration is approximately 39 inches. Rainfall can be intense during the summer thunderstorm season,

resulting in heavy runoff to surface water, drainage features, and the surrounding aquatic areas (Tampa Bay, Hillsborough Bay, mangrove swamps and creeks).

- o No major streams flow through the MacDill AFB area, but the base is drained by ditches, canals and creeks. These systems flow into Tampa Bay, Hillsborough Bay, and the mangrove swamps at the south end of the base, and are tidally influenced.
- o The subsurface materials at MacDill AFB consist of sediments and carbonate rocks. A water-table aquifer exists in the upper, surficial deposits of sand and clayey sands, which is hydraulically connected to the surface water system. Recharge to this water-table aquifer is from infiltration of local precipitation.
- o The Floridan Aquifer lies beneath the surficial aquifer and is generally separated from it by an intervening clay confining layer which prevents groundwater movement between the two aquifers. However, this confining layer is locally thin and may not be present in all areas.
- o General groundwater gradients in the Floridan Aquifer are low and movement is in a southerly direction away from MacDill AFB and toward the bay. Movement in the surficial aquifer is affected by tidal conditions and low gradients across MacDill AFB.
- o Except where tidally influenced, the surficial aquifer produces water of good quality, but it is not used locally as a water source. On MacDill AFB no water supply wells exist in the surficial aquifer.
- o The Floridan Aquifer is regionally important as a water supply source. Large wellfields north of Tampa take water from this aquifer. No water supply wells exist in the MacDill AFB area in the Floridan Aquifer. Water supply to MacDill AFB and the surrounding area comes from the city of Tampa.

These conditions produce an environmental setting with a low potential for contaminants to affect water supplies. However, the potential does exist for contaminant movement into aquifer systems and

into the surface water system including Hillsborough Bay, Tampa Bay, and local mangrove swamp environments.

2.2 AVON PARK AFR

2.2.1 Location

The Avon Park Air Force Range is located in central Florida in Polk and Highlands Counties approximately 65 miles east of Tampa (Figure 2.16). The range covers 106,210 acres, of which 103,484 are unimproved land (Figure 2.17).

2.2.2 Climate

The local climate at Avon Park AFR is very similar to that described for MacDill AFB. Average annual precipitation is approximately 48 inches and average annual evapotranspiration is approximately 40 inches per year. Rainfall can be intense during the summer thunderstorm season, resulting in heavy runoff to Arbuckle Creek and surface water drainage features on the base.

2.2.3 Topography and Physiography

Avon Park AFR is located within the Lake Wales Ridge and Osceola Plain physiographic regions (Figure 2.2). The Lake Wales Ridge region includes a narrow, elongated area of rolling uplands with numerous hills and lakes. Elevations range from 40 to 200 feet above msl. Most of the lakes are deep and circular and were created by sinkhole formation. The Osceola Plain region consists of flat areas bounded by the ridge on the west, extending to the coastal plain on the east. Elevations on the Osceola Plain range from 60 to 100 feet above msl (Fernald and Patton, 1984).

2.2.4 Surface Water Hydrology

The major surface water features at Avon Park AFR are Lake Arbuckle, Arbuckle Creek, and the surrounding wetlands (Figure 2.18). Lake Arbuckle is a sinkhole lake formed by subsidence of carbonate formations and may be hydraulically connected to the Floridan Aquifer System. The lake forms the northeastern boundary of the Auxiliary Airfield area and is drained by Arbuckle Creek south to Lake Istokpoga.

Arbuckle Creek is the main drainage feature at the Auxiliary Airfield. It flows south through wetland areas which border the airfield on the west. These wetlands and Arbuckle Creek receive flow from the rim canal which bounds the Auxiliary Airfield on the north,

FIGURE 2.16

AVON PARK AFR REGIONAL LOCATION MAP

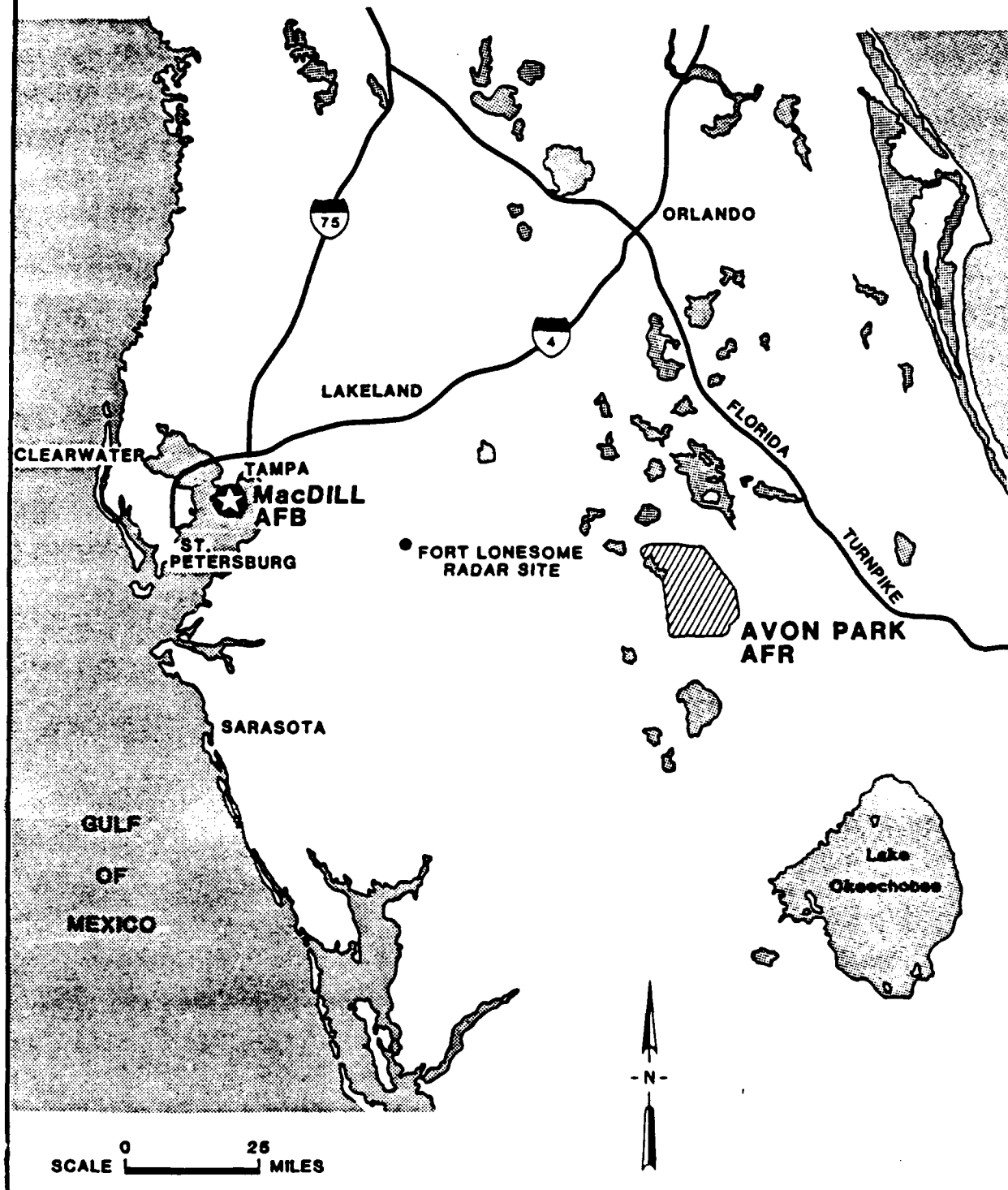


FIGURE 2.17

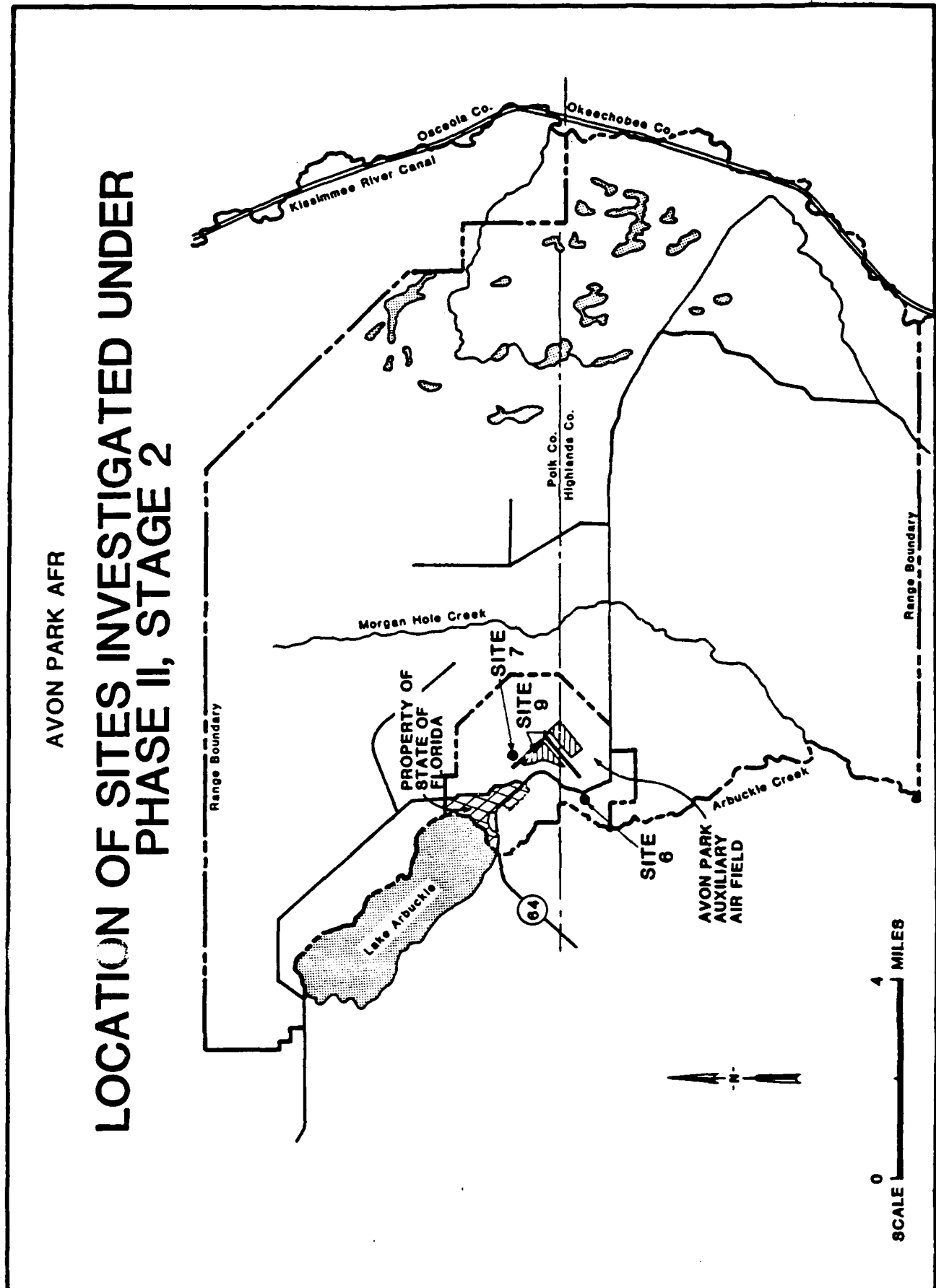
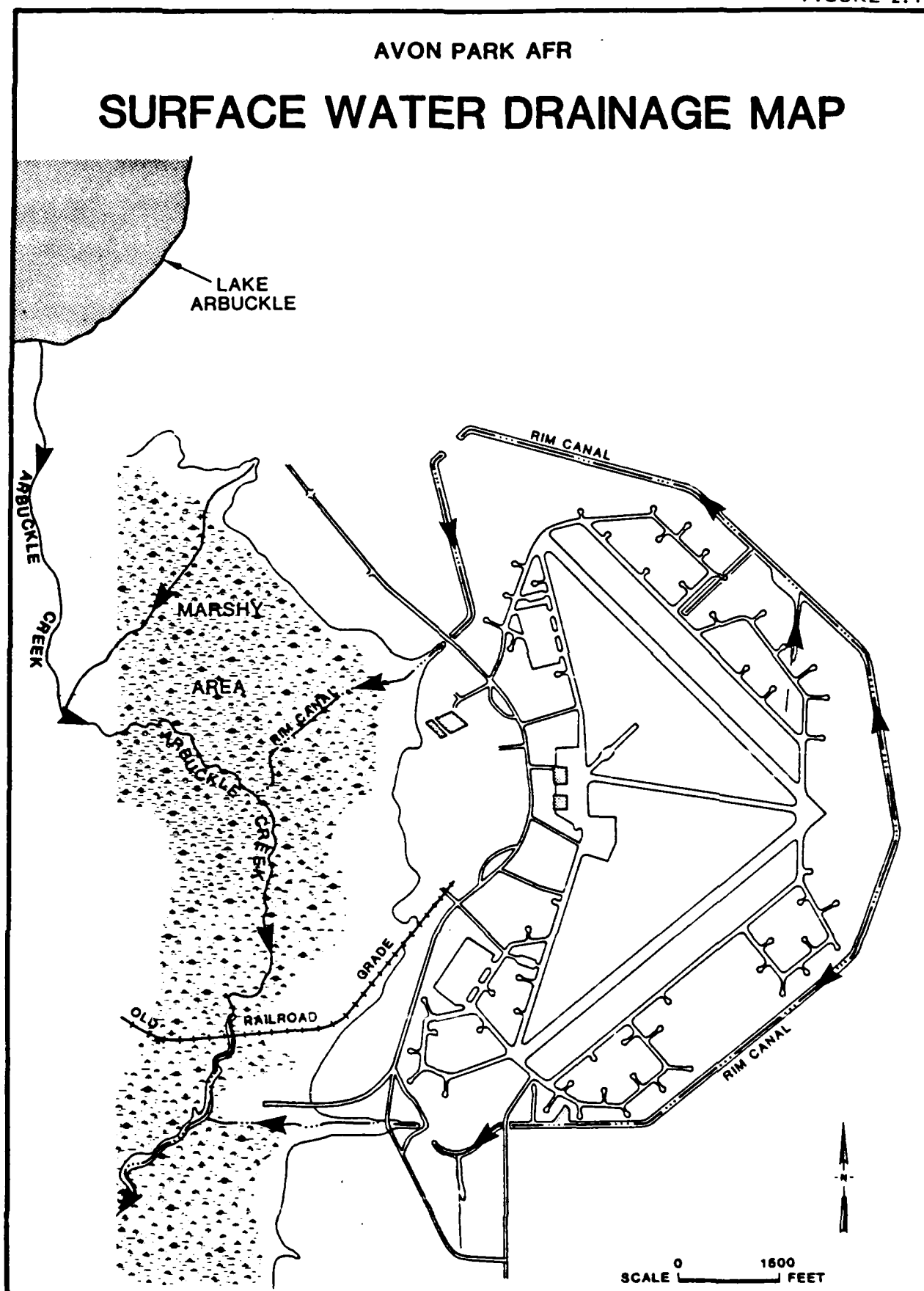


FIGURE 2.18



east, and south. Arbuckle Creek flows south to Lake Istokpoga which is part of the Kissimmee River System. Low relief and low runoff rates contribute to standing water and wet areas on the Auxiliary Airfield.

2.2.5 Local Geology

The uppermost deposits at Avon Park AFR are post-Miocene aged sands and clays which directly overlie the Miocene-aged Hawthorn Formation (Figure 2.5). The sand is quartzitic, fine to very fine grained and grades vertically into sandy clay, silty clay, and clay which comprises the uppermost Hawthorn Formation. The sand is generally 15 to 20 feet thick. At higher elevations along the ridge east of the base, surface sands extend to a thickness of 100 feet.

Below the surface sand, the Hawthorn Formation extends as a 300 foot thick sequence of clay, sand, and limestone which serves as a confining layer above the Floridan Aquifer. Beneath the Hawthorn lies the Miocene-aged Tampa Limestone which comprises the uppermost unit of the Floridan Aquifer. The Tampa Limestone is underlain by the Ocala Limestone. The Ocala is a late Eocene-aged coquina or fossiliferous micrite. The Ocala Limestone is approximately 200 feet thick beneath Avon Park AFR. Beneath the Ocala lies the Avon Park Formation. The Avon Park Formation is a 1700 foot thick sequence of brown limestone and dolomite. The Avon Park Formation has previously been referred to as two separate units, the Avon Park Limestone and the Lake City Limestone (Miller, 1986).

2.2.6 Local Hydrogeology

Groundwater at Avon Park AFR occurs in the surficial aquifer under water-table conditions. The surficial aquifer consists of fine to very fine sand and clayey sand which varies from 15 to 20 feet thick, based upon boreholes drilled at Avon Park AFR (Figures 2.19 and 2.20). The water table in the shallow aquifer varies from four to seven feet below ground surface. Groundwater flow direction in the surficial aquifer at the Avon Park AFR Auxiliary Airfield is generally northwest toward Lake Arbuckle (Figure 2.21). The shallow aquifer is directly connected to the surface water drainage on the base. The water table aquifer is recharged by infiltration of precipitation, and movement within this zone is very slow due to low hydraulic gradients. Discharge of groundwater from this zone may occur by evapotranspiration or lateral seepage into a stream, lake, or drainage ditch.

FIGURE 2.19

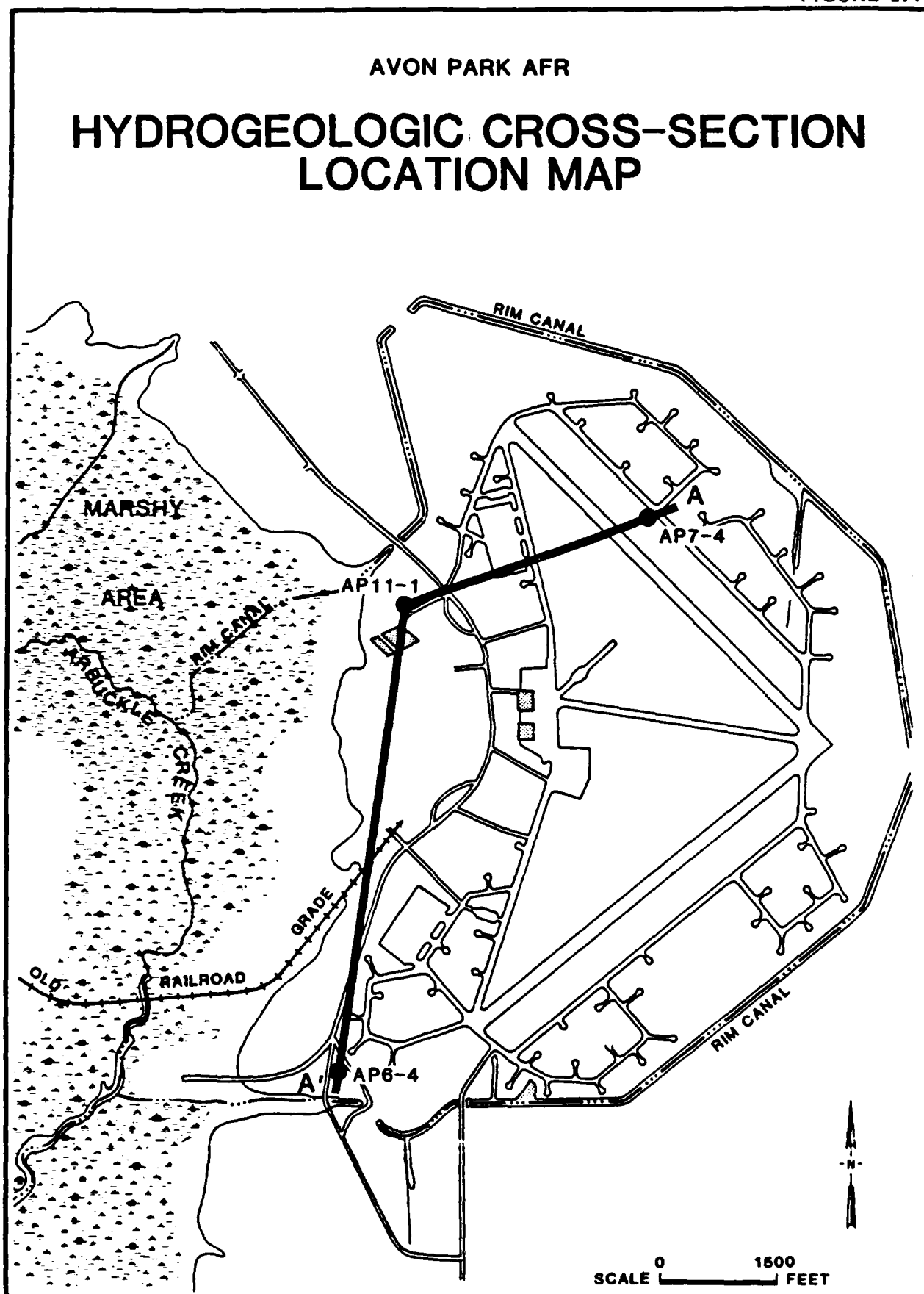


FIGURE 2.20

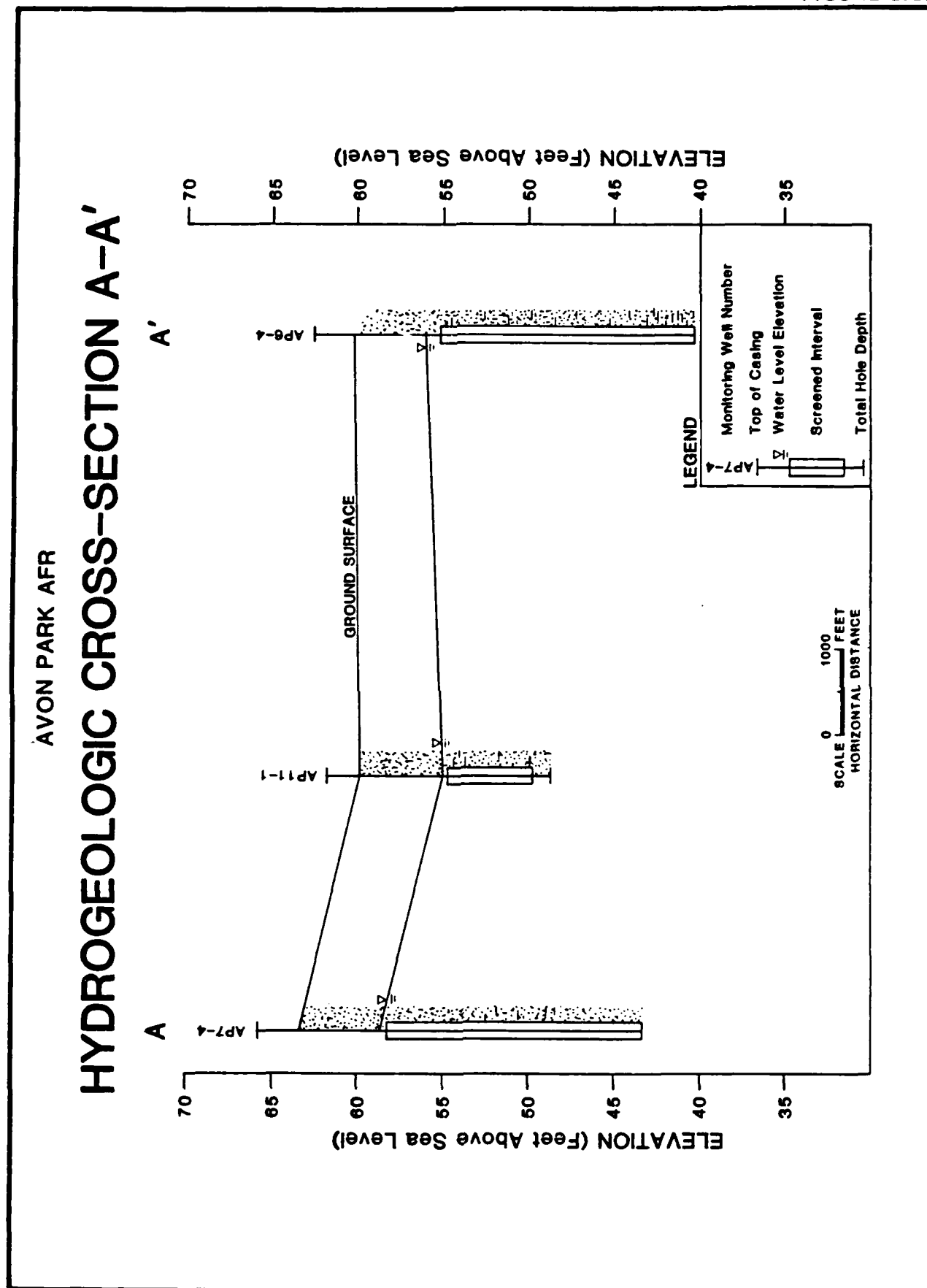
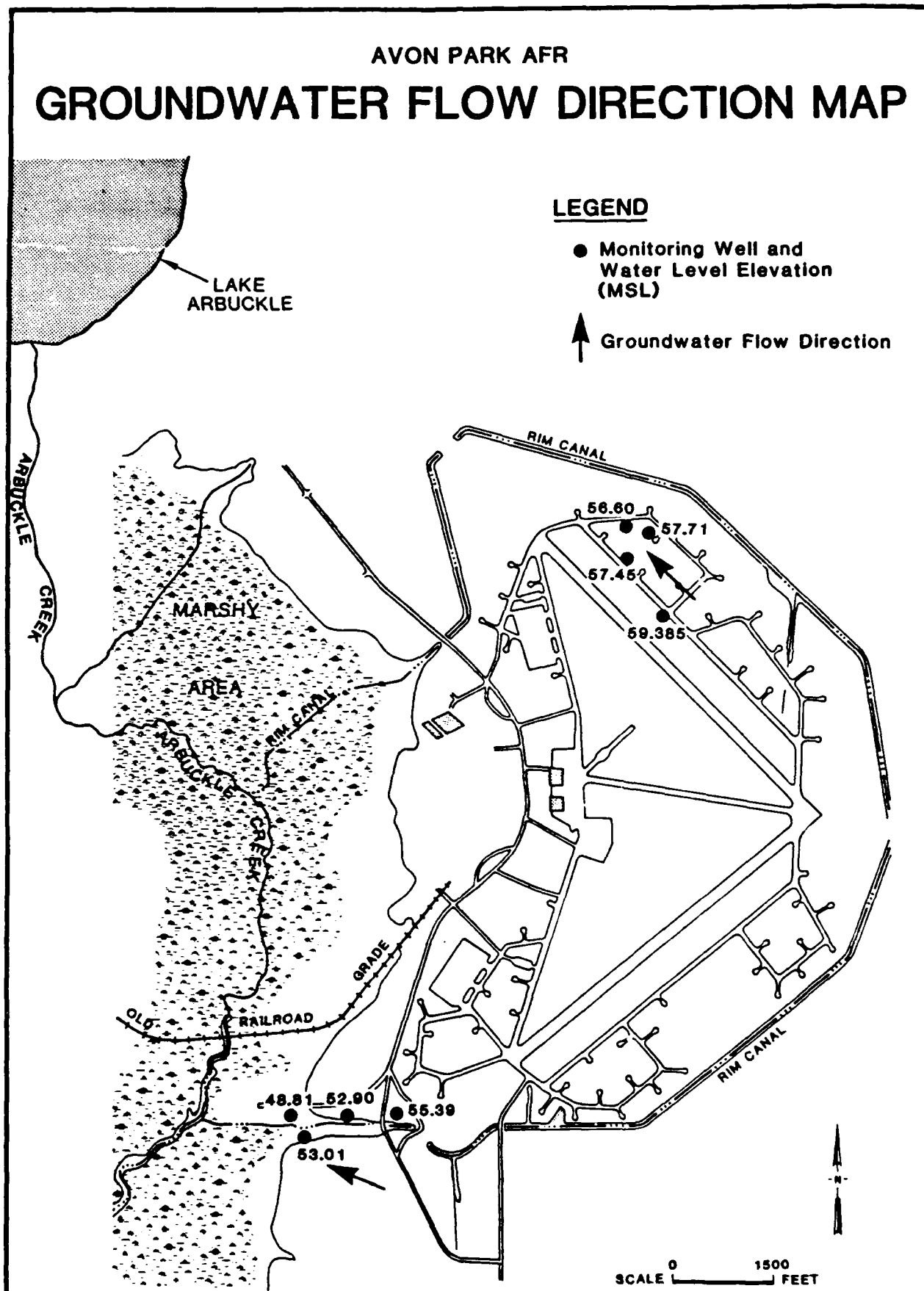


FIGURE 2.2



The Floridan Aquifer occurs under confined conditions beneath Avon Park AFR. The clay beds of the Hawthorn Formation form a 300 foot thick confining layer that limits vertical downward movement of water from the surficial aquifer and the vertical upward movement of water from the Floridan Aquifer. Interconnection between the two aquifers may occur where sinkholes have breached the Hawthorn Formation. Lake Arbuckle was formed by sinkhole subsidence and a hydraulic connection may exist between the two aquifers at that point. Contaminants reaching Lake Arbuckle may enter the Floridan Aquifer system if the clays of the Hawthorn have not "resealed" the lake bottom.

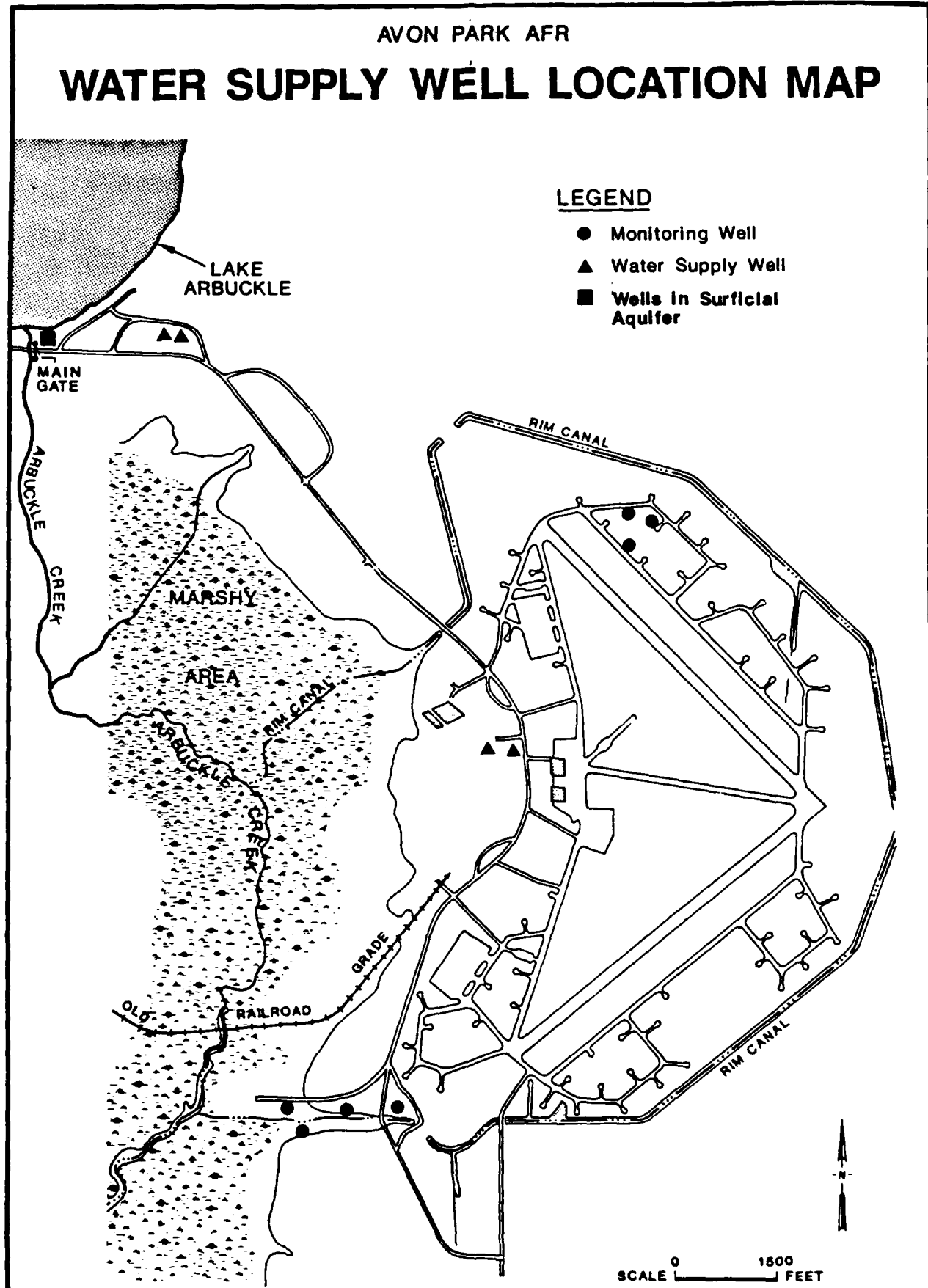
The Floridan Aquifer, specifically the lower portion of the Avon Park Formation, previously called the Lake City Limestone, provides nearly all the municipal and irrigation water supplies in the area. Avon Park AFR receives its water supply from two wells located near Lake Arbuckle and two wells located near the airfield (Figure 2.22). Additionally, several wells at the campground near Lake Arbuckle are completed in the surficial aquifer.

2.2.7 Summary of Environmental Setting at Avon Park AFR

The principal environmental conditions that could affect movement of contaminants at Avon Park AFR are summarized as follows:

- o Average annual precipitation is approximately 48 inches and average annual evapotranspiration is approximately 40 inches per year. Rainfall can be intense during the summer thunderstorm season, resulting in heavy runoff to Arbuckle Creek and surface water drainage features on the base.
- o The Floridan Aquifer lies beneath the surficial aquifer and is separated from it by a 300 foot thick clayey sequence of the Hawthorn Formation. This confining layer may be breached at Lake Arbuckle and other locations due to sinkhole collapse. The breach may cause a hydraulic connection between the surficial aquifer and the Floridan Aquifer.
- o The subsurface materials within the surficial aquifer consist of fine to very fine sand with varying amounts of silt and clay. The hydraulic conductivity of these sediments is low and results in very slow groundwater movement. The surficial

FIGURE 2.22



aquifer is directly connected to surface water drainage features such as Arbuckle Creek and the Rim Canal.

- o Four water supply wells exist on base: Two wells are located near Lake Arbuckle and two wells are located near the Auxiliary Airfield. These wells are completed in the Avon Park Formation (the Lake City Limestone). Additionally, several wells at the Avon Park AFR campground are completed in the surficial aquifer.

These conditions produce an environmental setting with a low potential for contaminants to affect water supplies. The potential does exist, however, for contaminant movement into the surficial aquifer and surface water systems.

SECTION 3
FIELD INVESTIGATION PROGRAM

SECTION 3

FIELD INVESTIGATION PROGRAM

The field investigation programs at MacDill AFB and Avon Park AFR included collecting site-specific hydrogeological data, and soil, sediment, surface water, and groundwater samples for chemical analysis from sites suspected of having environmental contamination due to past waste disposal practices. The data obtained in the field program were used to determine: (1) the presence or absence of contamination within the specified areas of the field survey; (2) the potential for contaminant migration within the specified areas of the survey; (3) the extent and magnitude of contamination; and, (4) the potential environmental consequences and health risks of contaminants (if found). This section discusses the scope of work and the procedures and methodology used in the field activities during the IRP Phase II, Stage 2 investigation at MacDill AFB and Avon Park AFR.

3.1 PROGRAM DEVELOPMENT

The IRP Phase II, Stage 2 field investigation program for MacDill AFB and Avon Park AFR was based on results of the Phase I effort (CH2M-HILL, 1981), the Phase II, Stage 1 effort (WAR, 1984), and subsequent technical reviews by the Air Force. From these reviews came the following decisions concerning the Stage 2 field investigation program:

- o Identification of sites for further investigation and new sites not previously investigated.
- o Identification of analytical requirements based upon previous analytical work and suspected contaminants at these sites.
- o Selection of field investigation and sampling techniques.

These decisions were the basis for a Phase II, Stage 2 program which involved work at the 12 sites identified in Table 1.1. The work

consisted of: geophysical surveys using electrical resistivity and magnetic methods; monitoring well installation; aquifer testing; sampling of soils, sediments, surface water, and groundwater; and chemical analysis of environmental samples.

3.2 GEOPHYSICAL SURVEYS

Electrical resistivity and/or magnetic geophysical surveys were made at five of the twelve sites. These geophysical methods assisted in defining locations of past disposal sites, identifying subsurface stratigraphic and lithologic features, detecting buried metallic objects, and selecting locations for the monitoring wells. The complete Geophysical Data Report, with detailed descriptions of the method used, is presented as Appendix F. An additional geophysical survey was made at Site No. 11 during a second field program in August 1987. This report has been added to Appendix F.

3.2.1 Magnetic Survey

The magnetic survey was conducted by taking magnetic field intensity measurements of the earth at regularly spaced stations. Station locations were established using a grid system that was laid out using a compass and a measuring tape. Stations were generally located at intervals of 10 feet. Measurements, in gammas, were obtained using a Geometrics Model G846 Proton Magnetometer.

3.2.2 Electrical Resistivity Survey

An electrical resistivity survey, which measures the electrical resistance of specific hydrogeologic settings to an induced current, was performed by taking both horizontal and vertical resistivity readings. Measurements, in ohms, were obtained using a Bison Earth Resistivity Meter Model 2350B.

Lateral changes in subsurface electrical properties were measured by a technique called profiling. Profiles were performed at a number of locations to measure areal changes in resistivity at given depths. The electrode configuration used was the standard Wenner Array, for which the depth of investigation is a subsurface zone roughly three-fourths to one times the electrode spacing.

Soundings were used to measure vertical variability of resistivity at individual surface points. The electrode configuration utilized for

soundings was the Modified Wenner Array (Carrington and Watson, 1981), for which the depth of subsurface investigated is roughly equal to the separation distance of the two potential electrodes.

3.3 DRILLING AND MONITORING WELL INSTALLATION

Monitoring wells were installed at seven sites on MacDill AFB and at two sites on Avon Park AFR. These wells were installed (1) to obtain geologic and stratigraphic information; (2) to obtain hydrogeologic information such as water level elevations and aquifer descriptions and characteristics; and (3) to obtain samples of the groundwater for chemical analysis. Twenty-seven wells were installed at MacDill AFB and two were installed at Avon Park AFR. Well construction details are presented in Table 3.1. Well construction diagrams, well completion forms, and field boring logs are presented as Appendix D.

The boreholes for all shallow wells at MacDill AFB and Avon Park AFR were drilled using a Mobile B-57 drilling rig utilizing twelve-inch diameter hollow-stem augers. Samples were collected at five-foot intervals during drilling using two-inch diameter split-spoon samplers. These samples were used for visual classification of soils and lithology changes, and for visual screening for contamination. Any obvious presence of contaminants, discoloration, or odors were noted in the boring logs. The borings and samples were also monitored using a photo-ionization detector, HNU Model PI 101, and an explosimeter. Logs were kept for each boring describing the soils, lithologies and the presence of any contaminant.

The borehole was advanced to the appropriate depth, and the well screen and casing was then installed through the hollow-stem. The wells were completed using two-inch diameter Schedule 40 PVC casing. The screen was also two-inch diameter Schedule 40 PVC with 0.010 inch slot size. All casing was threaded with flush joints. On occasion, the screen was connected to another segment of screen, or to blank casing using a PVC connector and stainless steel screws. The casing and screen were lowered through the hollow-stem auger and set at the determined depth. Silica sand (20-30 size) was poured in the annular space as the auger was withdrawn until the sand was a minimum of one-foot above the top of the screen. The boring was then sealed with a minimum one-foot

TABLE 3.1
MONITORING WELL CONSTRUCTION DETAILS

Well ID	Elevation Top of Casing (ft.) (MSL)	Total Hole Depth (ft.)	Well Completion Depth (ft.)	Surface Casing Interval	Screen Interval	Well Material	Well Diameter
MacDill, B MD8-1	9.22	22	17	NA	4-17	Sch 40 PVC	2 in.
MacDill, B MD8-2	10.81	17	14	NA	4-14	Sch 40 PVC	2 in.
MacDill, B MD8-3	9.67	23.5	14	NA	4-14	Sch 40 PVC	2 in.
MacDill, B MD8-4	9.72	17	15	NA	5-15	Sch 40 PVC	2 in.
MacDill, B MD8-5	9.62	18	17.5	NA	2.5-17.5	Sch 40 PVC	2 in.
MacDill, KD MD3-6	7.98	15	14	NA	4-14	Sch 40 PVC	2 in.
MacDill, RL MD58-5	7.57	22	14	NA	4-14	Sch 40 PVC	2 in.
MacDill, RL MD58-6	10.25	10	10	NA	4-10	Sch 40 PVC	2 in.
MacDill, RL MD9-4	8.46	17	12	NA	4-12	Sch 40 PVC	2 in.
MacDill, RL MD9-5	9.59	10	9	NA	4-9	Sch 40 PVC	2 in.
MacDill, RL MD9-6	9.60	17	14	NA	4-14	Sch 40 PVC	2 in.
MacDill, RL MD9-7	7.65	17	14	NA	4-14	Sch 40 PVC	2 in.
MacDill, CP MD13-1	17.47	27	20	NA	5-20	Sch 40 PVC	2 in.
MacDill, CP MD13-2	13.85	22	20	NA	5-20	Sch 40 PVC	2 in.
MacDill, CP MD13-3	14.19	22	20	NA	5-20	Sch 40 PVC	2 in.
MacDill, DS MD17-3	13.86	22	20.5	NA	5.5-20.5	Sch 40 PVC	2 in.
MacDill, DS MD17-4	12.78	13	12.5	NA	2.5-12.5	Sch 40 PVC	2 in.
MacDill, FA MD23-7	13.23	22	15	NA	5-15	Sch 40 PVC	2 in.
MacDill, FA MD23-8	13.26	22	15	NA	5-15	Sch 40 PVC	2 in.
MacDill, FA MD23-9	13.46	17	21	NA	4-21	Sch 40 PVC	2 in.
MacDill, FA MD23-10	12.03	17	14	NA	4-14	Sch 40 PVC	2 in.
MacDill, FA MD23-11	12.51	22	19	NA	4-19	Sch 40 PVC	4 in.
MacDill, FA MD23-12	13.00	20	15	NA	5-15	Sch 40 PVC	2 in.
MacDill, FA MD23-13	12.95	17	14	NA	4-14	Sch 40 PVC	2 in.
MacDill, FA MD23-14	12.56	17	14	NA	4-14	Sch 40 PVC	2 in.
MacDill, FA MD23-15	12.55	17	15	NA	4-14	Sch 40 PVC	2 in.
MacDill, FA MD23-D1	12.85	63	63	0-36	53-63	Sch 40 PVC	2 in.
MacDill, FA MD23-D2	15.32	90	90	0-31	70-90	Sch 40 PVC	2 in.
MacDill, FA MD23-D3	12.05	57	57	0-17	42-57	Sch 40 PVC	2 in.
MacDill, AO AP6-4	62.59	20	20	NA	5-20	Sch 40 PVC	2 in.
MacDill, AC AP7-4	65.87	20	20	NA	5-20	Sch 40 PVC	2 in.

layer of granular bentonite, and backfilled with neat cement grout to the surface. One well at Site No. 23 was installed using four-inch diameter Schedule 40 PVC screen and casing by the same procedure. Figure 3.1 shows the general construction details for the shallow wells.

The three deeper wells were constructed at Site No. 23 by drilling into the top of the Tampa Limestone using mud rotary methods. First, an eight inch diameter surface casing was installed into a twelve inch diameter boring that penetrated the top of the clay confining layer. The surface casing was grouted into the clay layer. Next, a six-inch mud rotary boring was drilled through the surface casing into the top of rock. Two-inch diameter schedule 40 PVC casing and screen was set into the six-inch boring. The deeper wells were completed as described above and as shown in Figure 3.2.

All wells had four-inch diameter steel security risers with locking caps installed around the PVC casing. Three steel guard posts were installed around the protective risers. All steel risers and guard posts were painted. All wells were developed by pumping until the discharge water was clear and free of sediment.

3.4 AQUIFER PUMPING TEST

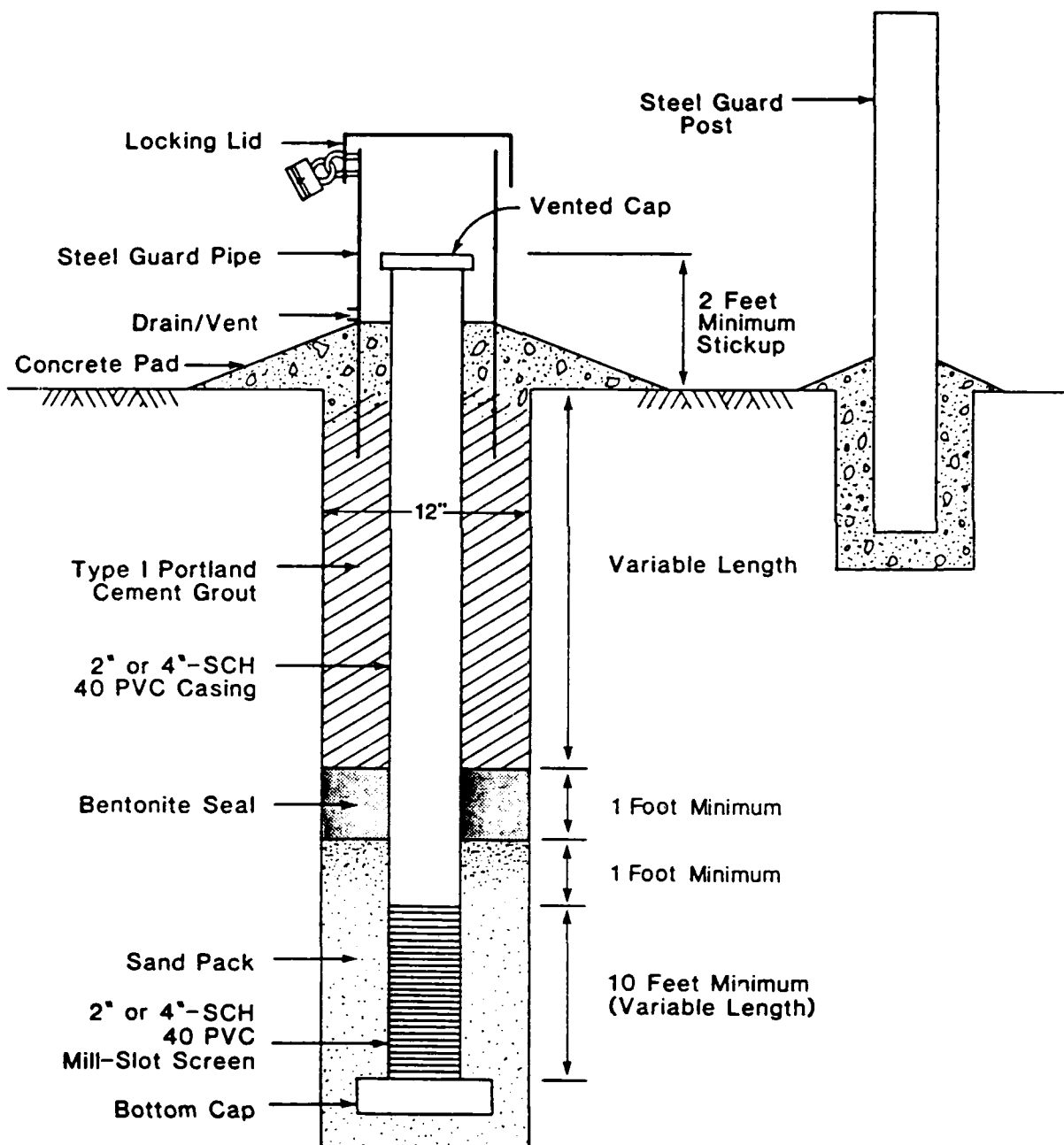
An aquifer pumping test was performed at Site No. 23 to determine the hydraulic characteristics of the surficial aquifer. The test was performed using well MD23-11 (which was completed as a 4-inch well) as the pumped well and well MD23-15 as an observation well. A submersible pump was installed in well MD23-11 and pumped at approximately 4.5 gallons per minute. The drawdown phase of the test was conducted for approximately ten hours; recovery data was collected for two hours. A complete description of the test with all field data and interpretive plots are included as Appendix E.

3.5 SAMPLE COLLECTION FOR CHEMICAL ANALYSIS

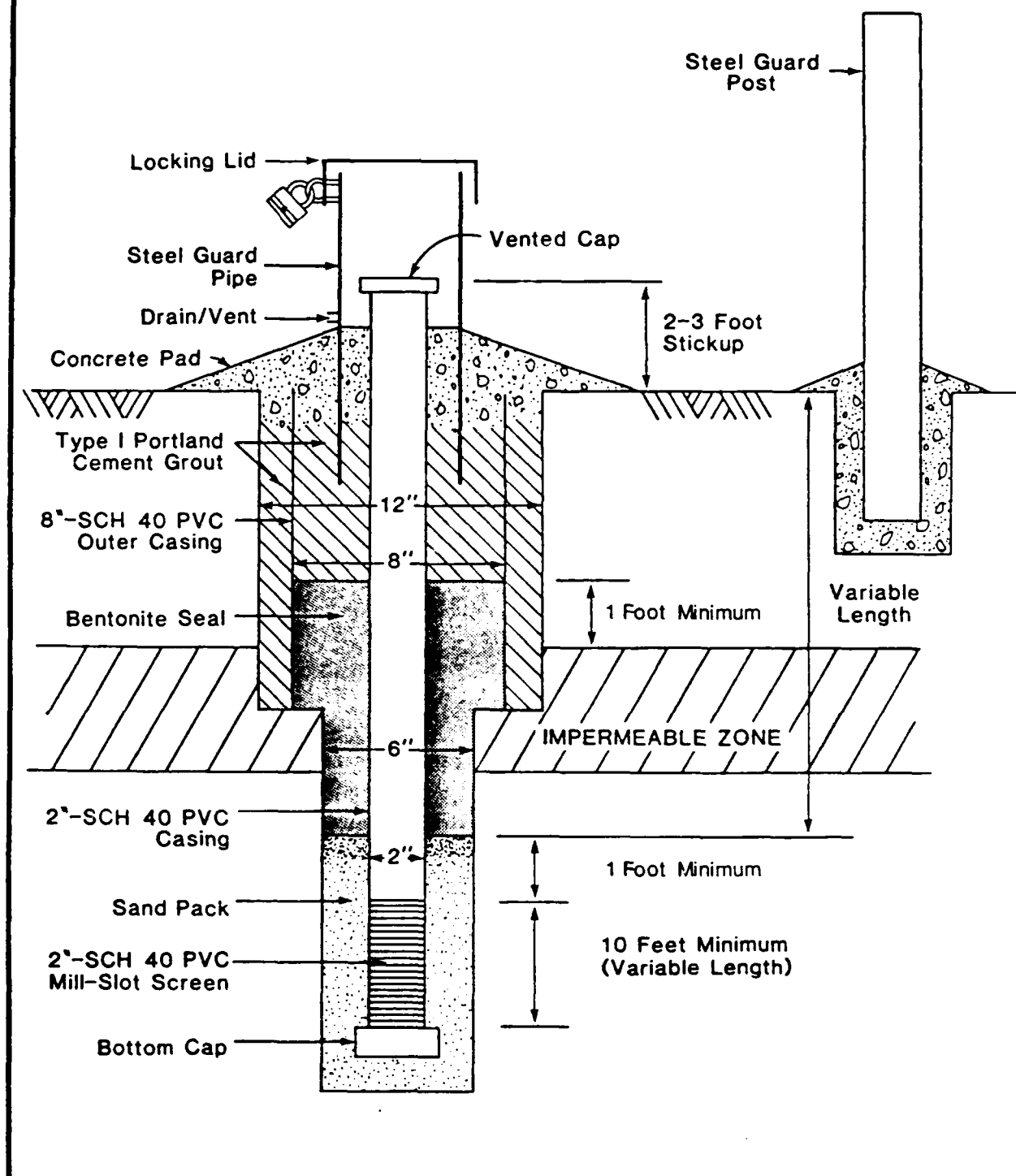
3.5.1 Surface Soil Samples

Soil samples were collected for chemical analysis at Avon Park AFR Site No. 9. The samples were taken at 0.5 foot depths using a shovel to dig to the proper depth. A stainless steel spoon was then used to collect and composite samples. All sampling equipment was cleaned and decontaminated prior to use as described below in Section 3.5.4.

MACDILL AFB - AVON PARK AFR
TYPICAL SHALLOW MONITORING WELL
CONSTRUCTION DETAILS



MACDILL AFB - AVON PARK AFB
TYPICAL DEEP MONITORING WELL
CONSTRUCTION DETAILS



3.5.2 Surface Water and Sediment Samples

Surface water and sediment samples were collected from six sites on MacDill AFB and one site on Avon Park AFR. Surface water samples were gathered by submerging the sample bottles directly into the drainage ditch or canal. Temperature, pH, and conductivity were measured and recorded. After obtaining water samples, sediment samples were collected from the ditch or canal bottom at the same location as the surface water samples. Sediment samples were collected using a tube type sampler or a shovel and bucket. All sampling equipment was cleaned and decontaminated prior to use at each location as described below.

3.5.3 Groundwater Sampling

All new monitoring wells and most existing monitoring wells at MacDill AFB and Avon Park AFR were purged and sampled for the Phase II, Stage 2 effort. Prior to sampling each well, the water level depth was measured using a electric water level indicator and the volume of water in the casing was calculated. The wells were purged using a 1.75-inch diameter hand pump. The amount removed was measured at the discharge outlet and five to ten volumes of water were purged from each well. Water levels were checked immediately prior to sampling to insure that water levels had recovered.

The wells were sampled using a decontaminated Teflon® bailer. Temperature, conductivity, and pH were measured in the field.

3.5.4 Decontamination of Sampling Equipment

All sampling equipment was cleaned and decontaminated prior to use at each sampling location by washing with detergent, rinsing with potable water, rinsing with methanol, and rinsing with large quantities of deionized water. Decontaminated tools and sampling equipment were kept on clean plastic prior to use and during sampling. Teflon® bailers were wrapped in aluminum foil for storage after decontamination.

A second sampling event was performed in August 1987. The decontamination procedures for sampling equipment were changed. The decontamination consisted of the following steps:

- o Wash with Alconox detergent.
- o Double rinse with organic free, ASTM Type II deionized water.
- o Rinse with pesticide-grade methanol.

- o Rinse with pesticide-grade hexane.
- o Air dry thoroughly and wrap in aluminum foil.

All sampling equipment was either wrapped in aluminum foil or placed on aluminum foil prior to use. No plastic sheeting or plastic bags were used around cleaned equipment.

3.6 SAMPLE NUMBERING SYSTEM

Each individual sample was assigned a unique sample identifier that describes the sample medium and where the sample was collected (Table 3.2). The sample identifier was the same on bottle labels, chain of custody forms, laboratory forms, any other reference to that particular sample. Each sample identifier consisted of a group of letter and numbers that identified:

- o The site name, a one or two letter abbreviation.
- o The MacDill AFB or Avon Park AFR identifier, "MD" or "AP".
- o The site number.
- o The sample matrix abbreviation, i.e., GW for groundwater, SW for surface water, SD for sediment, and SS for soil.
- o The sample number or well number.
- o The laboratory destination.

For example, a groundwater sample collected at MacDill AFB, Site No. 9, the recent landfill, from monitoring well number 3 at that site, which was sent to the ES laboratory, would receive the following number:

RL MD9-3 GW ES

Field duplicates and blanks collected for quality assurance purposes were also assigned unique sample identifiers. The sample number or well number was changed to a different numeral with no corresponding well or sampling location in the field. For example, a blind duplicate of the groundwater sample identified above would be: RL MD9-8 GW ES. The well number 8 is the change (only seven wells actually exist at that particular site). Records of all such quality assurance samples were kept in the field log books.

TABLE 3.2
SAMPLE NUMBERING SYSTEM

<u>Project Identification:</u>	MD	MacDill
	AP	Avon Park

Site Identification:

B	Former Fuel Storage Area No. 2 (Site B)
DK	Landfill at Dog Kennel (Site No. 3)
PL	Past Landfills (Site No. 5-8)
RL	Recent Landfills (Site No. 9)
CM	Chemical Munitions Burial Area (Site No. 11)
CP	Creosote Pit (Site No. 13)
FT	Fuel Tank Farm (Site No. 16)
DS	Drum Storage Area (Site No. 17)
FA	Fire Training Area (Site No. 23)
AO	Old Landfill, Avon Park AFR (Site AP-6)
AC	Recent Landfill, Avon Park AFR (Site AP-7)
AA	Army Test Site, Avon Park AFR (Site AP-9)

Type of Sample:

GW	Groundwater
SW	Surface Water
SD	Sediment

Laboratory Identification:

ES	Engineering Science (Savannah Laboratories and Environmental Services, Inc.)
OEHL	USAF Occupational and Environmental Health Laboratory

Example Sample Numbers:

MacDill DK MD3-1 GW ES

MacDill Air Force Base, Landfill at Dog Kennel (Site 3), well number MD3-1, groundwater sample, sent to Engineering-Science Laboratory for analysis.

MacDill RL MD9-SW2 OEHL

MacDill Air Force Base, Recent Landfill (Site 9), surface water sample number 2, sent to USAF Occupational and Environmental Health Laboratory for analysis.

3.7 SAMPLE HANDLING, PACKAGING, AND SHIPMENT

All samples and duplicates were collected directly in pre-cleaned glass and plastic bottles for shipping to the laboratory. These containers were supplied pre-cleaned according to EPA procedures by I-Chem Research, Inc., of Hayward, California. When required for a particular analysis, preservatives were added to the containers immediately before sample collection. Each sample container was sealed by a Teflon®-lined cap that was taped shut using polyethylene tape to ensure it remained sealed during shipment. Individual bottles were then wrapped in bubble pack to prevent breakage during shipment.

Individual sample containers were labeled with the following information:

- o Project identifier (MacDill AFB).
- o Sample identifier (as described above).
- o Preservatives added (specific for analytical method).
- o Date of sample collection.
- o Time of sample collection.
- o Required analytical method (specific for each container).

The individual containers for one analysis were all placed together in a sealed plastic bag to prevent cross-contamination in the event of container breakage during shipment. These bags were then placed into insulated shipping coolers, along with a sealed plastic bag containing ice.

A chain-of-custody form with the following information was completed and sealed inside each cooler in a waterproof envelope prior to shipping:

- o Project identifier (MacDill AFB).
- o Name and signature of person who collected the samples.
- o Sample identifiers (for all samples in the cooler).
- o Date and time of sample collection.
- o Number of individual containers for each sample.
- o Required analytical methods for each sample.

The shipping coolers were sealed shut with security labels taped over opposite ends of the lid. The coolers were placed in cardboard mailers and shipped for overnight delivery to the laboratory. Copies of the completed chain-of-custody forms obtained from the laboratory upon completion of analytical effort and sample disposal are presented as Appendix H.

Blind duplicates shipped for quality assurance (QA) purposes were routinely included in shipments along with other samples, and their unique sample identifiers (see above) should have made them indistinguishable from normal samples to the laboratory personnel.

As an additional quality assurance measure, duplicates of samples shipped for chemical analysis (ten percent of the total number of samples) were also shipped to the USAF Occupational and Environmental Health Laboratory (USAFOEHL/SA) at Brooks AFB, Texas. The selection as to which duplicate samples would be mailed to OEHL was made by the MacDill AFB Bioenvironmental Engineer. These samples were given identical sample identifiers (except for the destination laboratory abbreviation).

3.8 CHEMICAL ANALYTICAL METHODS AND PROCEDURES

Individual samples were analyzed in the laboratory for selected parameters, as described below in Subsection 3.9. The analytical methods followed were all standard, published procedures, as summarized in Table 3.3. The target detection limits achieved for each method are presented in Appendix I, Tables I.1 and I.2. In accordance with the Statement of Work (SOW) presented as Appendix G, second-column GC analyses were performed to confirm the identity of any compounds found in the samples at concentrations exceeding the target detection limits.

All samples were prepared for analysis in accordance with the published methods listed in Table 3.3. All water samples were shipped to the laboratory and analyzed unfiltered.

Internal quality control (QC) samples were routinely run by the laboratory at a frequency of approximately 10 percent. These included matrix spikes, method blanks, and duplicates. Blind field blanks and duplicates were analyzed as quality assurance (QA) samples at an overall level of about 10 percent. A summary of QC and QA results is presented in Appendix I.

TABLE 3.3
ANALYTICAL PARAMETERS AND METHODS
USED AT MACDILL AFB AND AVON PARK AFB

Parameter	Method	Reference
<u>Groundwater and Surface Water Samples</u>		
Purgeable Organics	E601 and E602	1
Purgeable Organics with Xylenes	E601 and SW5030/8020	1 2
Base/Neutral and Acid Extractable Organics	E625	1
1,2-Dibromoethane (EDB)	E502.1	3
Petroleum Hydrocarbons	E418.1	4
Cadmium (Cd)	E213.2	4
Chromium (Cr)	E218.2	4
Lead (Pb)	E239.2	4
Zinc (Zn)	E289.1	4
Metals Scan	E200.7 and	4
(Mercury, Hg)	E245.1 and	4
(Arsenic, As)	E206.2 and	4
(Antimony, Sb)	E204.2 and	4
(Molybdenum, Mo)	E246.2 and	4
(Lead, Pb)	E239.2 and	4
(Selenium, Se)	E270.2	4
pH (field measurement)	E150.1	4
Specific Conductance (Field Measurement)	E120.1	4
Temperature (Field Measurement)	E170.1	4
<u>Soil and Sediment Samples</u>		
Volatile Organics	SW5030/8240	2
Semi-volatile Organics	SW3550/8270	2
Chlorinated Herbicides	SW8150	2
2,3,7,8 - TCDD (dioxin)	SW3550/8280	5

TABLE 3.3
(Continued)
ANALYTICAL PARAMETERS AND METHODS
USED AT MACDILL AFB AND AVON PARK AFB

Parameter	Method	Reference
Petroleum Hydrocarbons	SW3550/E418.1	2/4
Cadmium (Cd)	SW3050/7130	2
Chromium (Cr)	SW3050/7190	2
Lead (Pb)	SW3050/7420	2
Zinc (Zn)	SW3050/7950	2
Metals Scan (Mercury, Hg)	SW1310/6010 and SW7471	2

References:

1. Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA-600/4-82-057, US EPA Environmental Monitoring and Support Laboratory, July 1982.
2. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW 846, US EPA Office of Solid Waste and Emergency Response, 2nd Edition, July 1982 (Update, Number II, 1985).
3. Determination of Halogenated Chemicals in Water by the Purge and Trap Method, EPA-600/4-81-059, US EPA Environmental Monitoring and Support Laboratory, April 1981.
4. Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, US EPA Environmental Monitoring and Support Laboratory, Revised March 1982.
5. 40 CFR 261, Appendix X - "Methods of Analysis for Chlorinated Dibenzo-P-Dioxins and Dibenzofurans," Federal Register 50 2001, January 14, 1985.

3.9 SITE-SPECIFIC FIELD PROGRAM DETAILS

A summary of the site-specific field investigations and a listing of the analytical parameters are presented in Table 3.4. Activities at individual sites are described below.

3.9.1 Former Fuel Storage Area No. 2 (Site B)

The field program at Site B consisted of geophysical surveys, using electrical resistivity (ER) and magnetic methods, and the installation and sampling of five monitoring wells at the locations shown in Figure 3.3. The magnetic survey was used to locate the buried tanks. The ER survey was performed to aid in locating any identifiable contaminant plumes and subsurface stratigraphic and lithologic features such as the uppermost sand aquifer and the underlying clay confining layer.

Monitoring wells MDB-1, MDB-2, MDB-3 and MDB-4 were drilled to depths of 17 feet, 14 feet, 14 feet, and 15 feet, respectively. MDB-1 was located north-west of the site just off Short Cut Road. MDB-2 was located along the south-west edge of the site, near the South Apron. MDB-3 and MDB-4 were located along the south-eastern edge of the site near Building 90. These four wells were installed to aid in defining shallow subsurface lithology, groundwater flow directions, and water quality at Site B. Groundwater samples collected from these wells were analyzed for purgeable organics including xylenes, EDB, petroleum hydrocarbons and lead. The temperature, pH, and specific conductance of the groundwater samples were measured at the time of sampling.

Additional work was conducted at Site B during August 1987 which included the installation of an additional monitoring well and the collection and analysis of a second round of groundwater samples from all wells. The additional monitoring well MDB-5 was installed between wells MDB-1 and MDB-4 along Short Cut Road, and was drilled to a depth of 13 feet. The second round of groundwater samples were analyzed for purgeable organics including xylene, petroleum hydrocarbons, and lead.

3.9.2 Landfill at Dog Kennel (Site No. 3)

The field program at Site No. 3 consisted of an electrical resistivity (ER) survey, the installation of one upgradient monitoring well, and the collection of surface water, sediment, and groundwater samples. The ER survey was performed to qualitatively identify the extent of any leachate plumes.

TABLE 3.4
SUMMARY OF THE FIELD PROGRAM FOR THE IPP PHASE II-STAGE 2
INVESTIGATION AT MACVILL AFB AND AVON PARK AFB

Site Name	Field Activities	Number & Kind of Samples	Sample Analysis	Analysis Method
<u>First Field Investigation, October 1986</u>				
Site B - Former Fuel Storage Area No. 2	Perform geophysical surveys - electrical resistivity and magnetic. Install four shallow monitoring wells. Sample four new monitoring wells.	Four groundwater samples	Purgeable Organics with Xylene EDR Petroleum Hydrocarbons Lead	E601, SW5030/R020 E502.1 E418.1 E239.2
Site 3 - Landfill at Dog Kennel	Perform geophysical survey, electrical resistivity. Install one shallow monitoring well. Sample sediment and surface water from drainage ditches, seven locations. Sample four monitoring wells - one new well, three existing wells.	Seven sediment samples Five surface water samples and four groundwater samples	Purgeable Organics Base/Neutral and Acid Extractable Organics Metals Scan Purgeable Organics Base/Neutral and Acid Extractable Organics Metals Scan	SW5030/R240 SW3550/R270 SW1310/6010, SW7471 E601/602 E625 E200.7/245.1
Sites 5-8 Past Landfills	Install two shallow monitoring wells. Sample sediment and surface water from drainage ditches, five locations. Sample six monitoring wells - two new wells and four existing wells.	Five sediment samples Five surface water and six groundwater samples	Purgeable Organics Base/Neutral and Acid Extractable Organics Metals Scan Purgeable Organics Base/Neutral and Acid Extractable Organics Metals Scan	SW5030/R240 SW3550/R270 SW1310/6010, SW7471 E601/602 E625 E200.7/245.1
Site 9 - Recent Landfill	Perform geophysical survey, electrical resistivity. Install four shallow monitoring wells.	Two sediment samples	Purgeable Organics Base/Neutral and Acid Extractable Organics Metals Scan	SW5030/R240 SW3550/R270 SW1310/6010, SW7471

TABLE 3.4
SUMMARY OF THE FIELD PROGRAM FOR THE IRP PHASE II-STAGE 2
INVESTIGATION AT MACDILL AFB AND AVON PARK AFB (Continued)

Site Name	Field Activities	Number & Kind of Samples	Sample Analysis	Analysis Method
Site 9 - Recent Landfill (con't)	Sample sediment and surface water from drainage ditch, two locations. Sample six monitoring wells - four new wells and two existing wells.	Two surface water and six groundwater samples	Purgeable Organics Base/Neutral and Acid Extractable Organics Metals Scan	P601/602 P625 E200.7/245.1
Site 11 - Chemical Munitions Burial Area	Further records search investigation. Sample sediment and surface water from canal, three locations.	Three sediment samples	Purgeable Organics Base/Neutral and Acid Extractable Organics Metals Scan	SW5030/8240 SW3550/8270 SW1310/6010, SW7471
Site 13 - Creosote Pit	Perform geophysical survey, electrical resistivity. Install three shallow monitoring wells. Sample three new monitoring wells.	Three surface water samples Three groundwater samples	Purgeable Organics Base/Neutral and Acid Extractable Organics Metals scan Base/Neutral and Acid Extractable Organics	P601/602 P625 E200.7/245.1 P625
Site 16 - Fuel Tank Farm	Sample sediment and surface water from ditch and canal, six locations.	Six surface water samples	Petroleum Hydrocarbons Purgeable Organics with Xylene FDB Lead	E418.1 P601, SW5030/8020 E502.1 E239.2
Site 17 - Drum Storage Area	Install one shallow monitoring well. Sample sediment and surface water from drainage ditch, three locations.	Six sediment samples Three sediment samples	Petroleum Hydrocarbons Purgeable Organics Lead Purgeable Organics Base/Neutral and Acid Extractable Organics Lead Cadmium Zinc Chromium	SW3550/8418.1 SW5030/8240 SW3050/7420 SW5030/8240 SW3550/8270 SW3050/7420 SW3050/7130 SW3050/7950 SW3050/7190

TABLE 3.4
SUMMARY OF THE FIELD PROGRAM FOR THE IPR PHASE II-STAGE 2
INVESTIGATION AT MACDILL AFB AND AVON PARK AFB (Continued)

Site Name	Field Activities	Number & Kind of Samples	Sample Analysis	Analysis Method
Site 17 - Drum Storage Area (Continued)	Sample three monitoring wells - one new well and two existing wells.	Three surface water and three groundwater samples	Purgeable Organics Base/Neutral and Acid Extractable Organics Lead Cadmium Zinc Chromium	E601/602 E625 E239.2 E213.2 E289.1 E218.2
Site 23 - Fire Training Areas	Perform geophysical survey, electrical resistivity. Install three monitoring wells, 51-70 feet deep. Install eight shallow monitoring wells and one shallow observation well. Conduct aquifer pumping test.	Seventeen groundwater samples	Purgeable Organics Petroleum Hydrocarbons Lead	E601/602 E418.1 E239.2
Site AP-6 - Old Landfill, Avon Park	Install one shallow monitoring well. Sample sediment and surface water from rim canal, three locations. Sample four monitoring wells - one new well and three existing wells.	Three sediment samples Three surface water and four groundwater samples	Purgeable Organics Base/Neutral and Acid Extractable Organics Petroleum Hydrocarbons Metals Scan Purgeable Organics Base/Neutral and Acid Extractable Organics Petroleum Hydrocarbons Metals Scan	SW5030/R240 SW3550/R270 SW3550/E418.1 SW1310/6010, SW7471 E601/602 E625 E418.1 E200.7/245.1
Site AP-7 - Recent Landfill, Avon Park	Install one shallow monitoring well. Sample four monitoring wells - one new well and three existing wells.	Four groundwater samples	Purgeable Organics Base/Neutral and Acid Extractable Organics Petroleum Hydrocarbons Metals Scan	E601/602 E625 E418.1 E200.7/245.1
Site AP-9 - Army Test Area, Avon Park	Sample upper six inches of soil at ten locations.	Ten soil samples	Dioxins Herbicides	SW3550/R280 SW8150

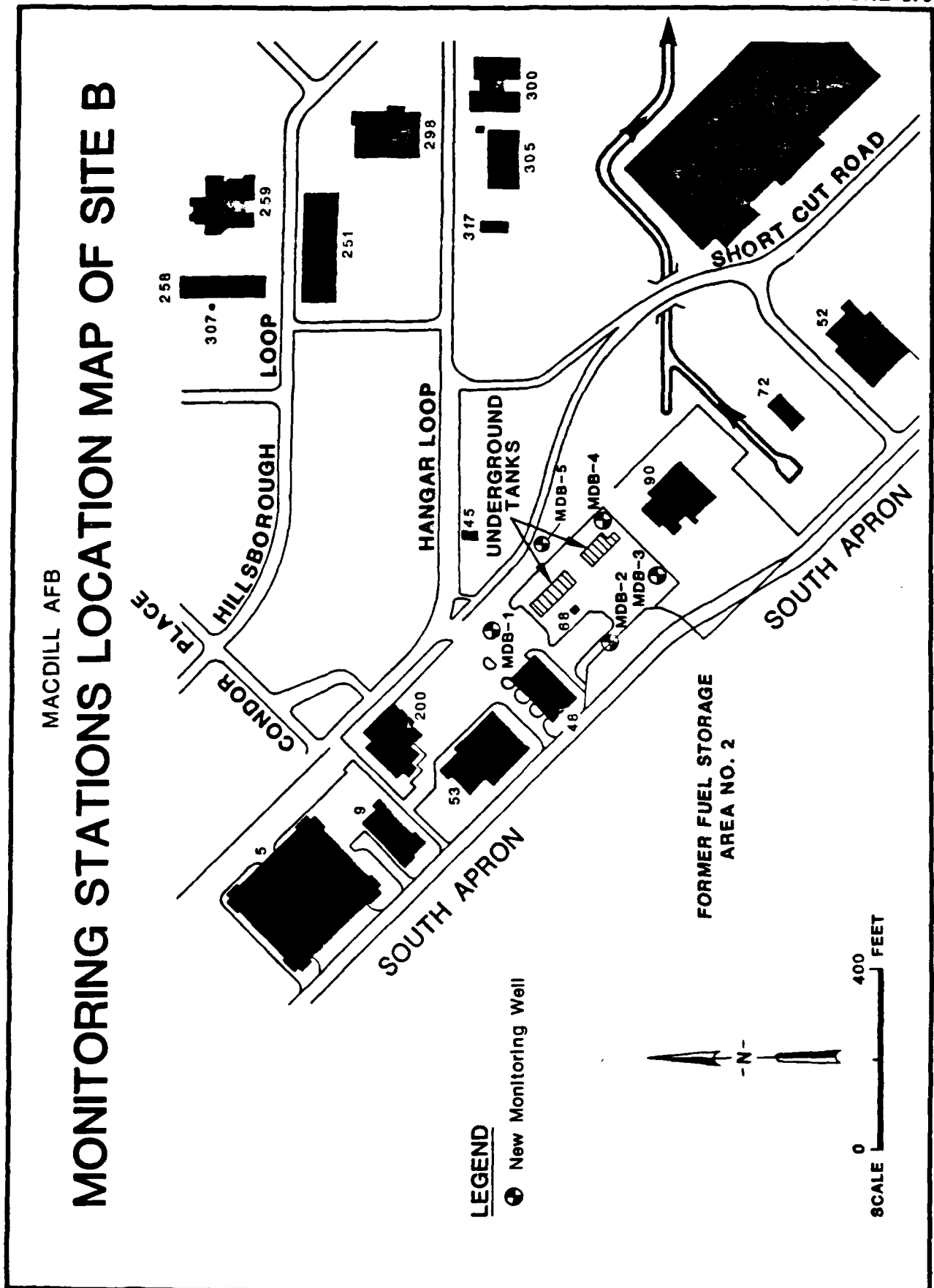
TABLE 3.4
SUMMARY OF THE FIELD PROGRAM FOR THE IRP PHASE II-STAGE 2
INVESTIGATION AT MACDILL AFB AND AVON PARK AFB (Continued)

Site Name	Field Activities	Number & Kind of Samples	Sample Analysis	Analysis Method
Second Field Investigation, August 1987				
Site B - Former Fuel Storage Area No. 2	Install one shallow monitoring well.	Five groundwater samples	Purgeable Organics with Xylene	E601, SW5030/8020
	Sample five monitoring wells.		Petroleum Hydrocarbons Lead	E418.1 E239.2
Site 3 - Landfill at Dog Kennel	Sample four monitoring wells.	Four groundwater samples and five surface water samples	Base/Neutral and Acid Extractable Organics	E625
	Sample five surface water stations.			
Site 5-8 - Past Landfills	Sample six monitoring wells and five surface water stations.	Six groundwater and five surface water samples	Purgeable Organics Base/Neutral and Acid Extractable Organics	E601/602 E625
Site 9 - Recent Landfill	Sample six monitoring wells and four surface water stations.	Six groundwater and four surface water samples	Purgeable Organics Base/Neutral and Acid Extractable Organics	E601/602 E625
Site 11 - Chemical Munitions Burial Area	Perform EM and Magnetic Survey.			
Site 17 - Drum Storage Area	Install one shallow monitoring well.	Four groundwater and two surface water samples	Purgeable Organics Base/Neutral and Acid Extractable Organics	E601/602 E625
	Sample four monitoring wells and two surface water stations.			

"E" Method - USEPA, Federal Register, Vol. 49, No. 209, 26 Oct 1984.

"SW" Method - Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.
SW 846 - Second Edition, USEPA, 1984.

FIGURE 3.3



Monitoring well MD3-6 was installed north of the site on the northern side of Southshore Road (Figure 3.4) and was drilled to a depth of 14 feet. This well was installed as an upgradient monitoring well and to help define shallow subsurface lithology. Groundwater samples were collected from existing wells MD3-1, MD3-2, MD3-3 and the new well MD3-6 (Wells MD3-4 and MD3-5 were not sampled during the Phase II, Stage 2 effort.) These samples were analyzed for purgeable organics, base/neutral and acid extractable organics, and metals.

Surface water and sediment samples were taken at seven locations in the drainage ditches which form the boundaries of the site (Figure 3.4). The sediment and surface water samples were also analyzed for purgeable organics, base/neutral and acid extractable organics, and metals. The temperature, pH, and specific conductance of the groundwater and surface water samples were measured at the time of sampling.

Additional fieldwork conducted at Site No. 3 in August 1987 included the collection and analysis of samples from surface water stations SW-1 to SW-5 and groundwater monitoring wells MD3-1, MD3-2, MD3-3, and MD3-6. The samples were analyzed for base/neutral and acid extractable organics.

3.9.3 Past Landfills (Sites No. 5-8)

The field program at Sites No. 5-8 consisted of drilling two upgradient monitoring wells and collecting sediment, surface water and groundwater samples. Monitoring wells MD58-5 and MD58-6, located along the northern side of Southshore Road (Figure 3.5), were drilled to depths of 14 feet and 10 feet, respectively.

Groundwater samples were collected from both new wells and from existing wells MD58-1, MD58-2, MD58-3 and MD58-4. The groundwater samples were analyzed for purgeable organics, base/neutral and acid extractable organics, and metals. Sediment and surface water samples were collected at five locations along the drainage ditch which forms the southern boundary of Sites 5-8 (Figure 3.5). These samples were analyzed for the same parameters as the groundwater samples. Temperature, pH, and specific conductance of groundwater and surface water samples were measured at the time of sampling.

A second round of sampling was conducted at Sites No. 5-8 in August 1987. Samples were collected from the surface water stations and all

FIGURE 3.4

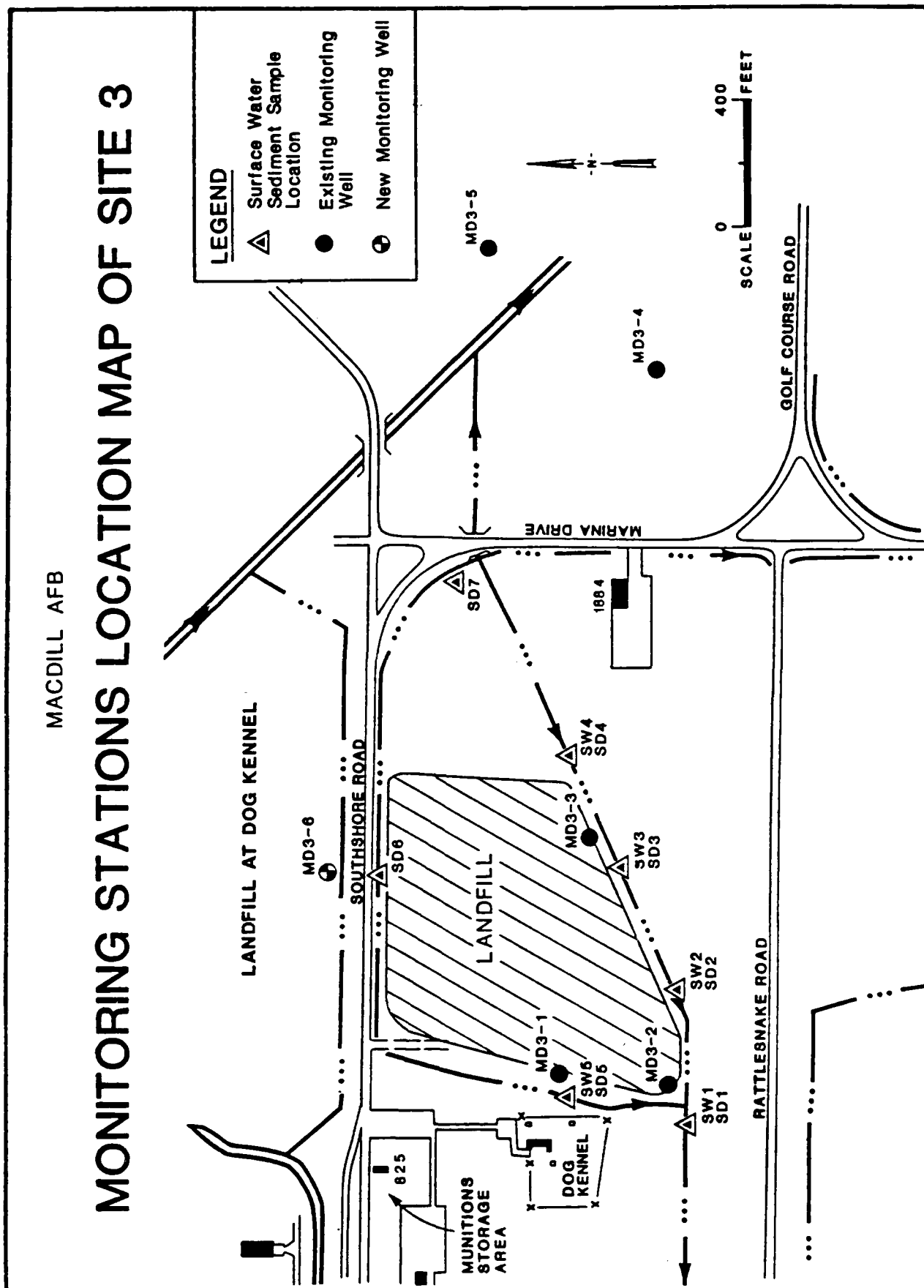
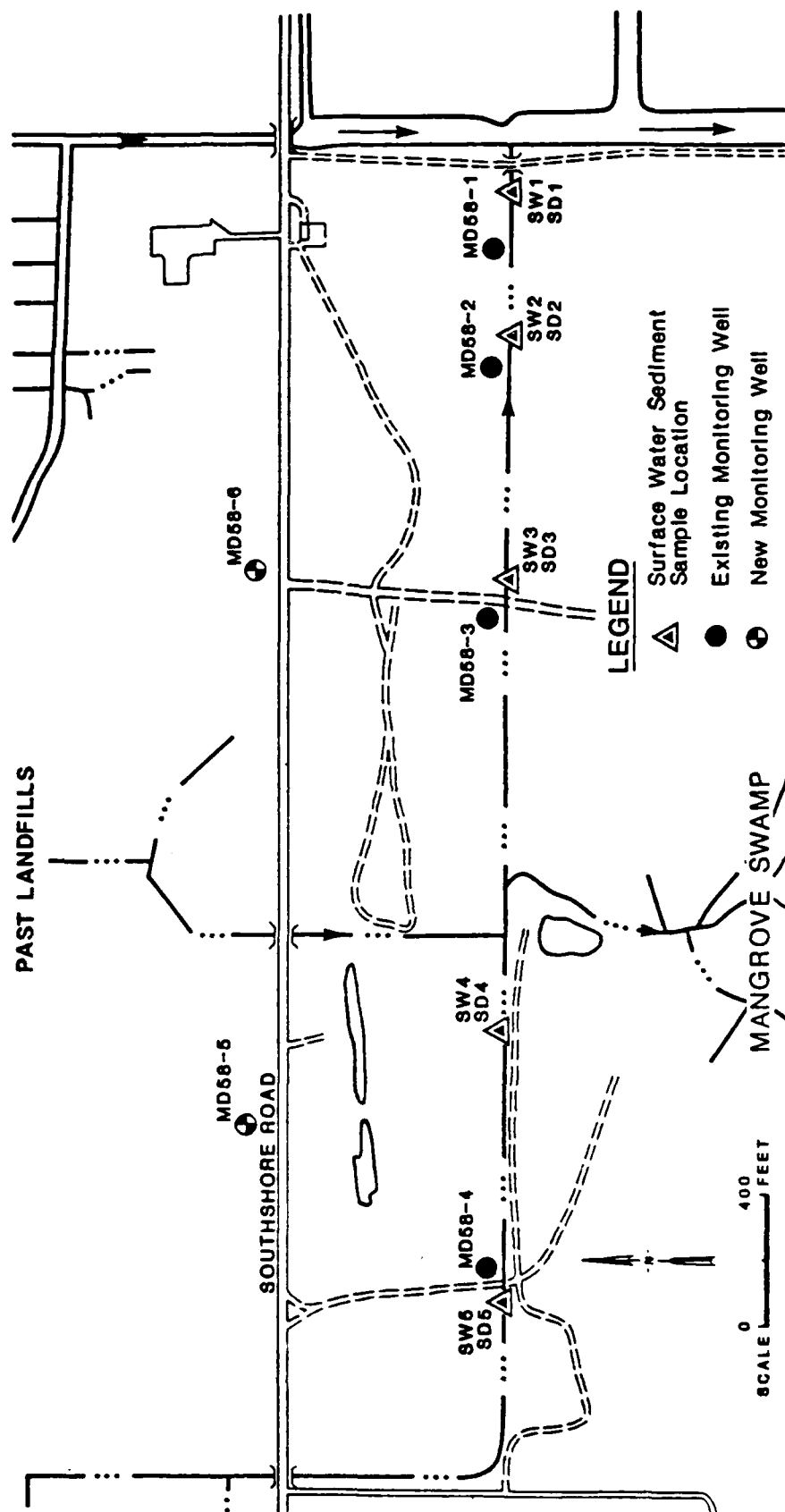


FIGURE 3.5

MACDILL AFB MONITORING STATIONS LOCATION MAP OF SITE 5-8



monitoring wells and analyzed for purgeable organics and base/neutral and acid extractable organics.

3.9.4 Recent Landfill (Site No. 9)

The field program at Site No. 9 included an electrical resistivity (ER) survey, the installation of four monitoring wells, and the collection of sediment, surface water, and groundwater samples. The ER survey was performed to qualitatively identify the extent of any leachate plumes.

Monitoring wells MD9-4, MD9-5, MD9-6 and MD9-7 were drilled to depths of 12 feet, 9 feet, 14 feet, and 14 feet, respectively. Monitoring well MD9-4 was located at the corner of Rattlesnake Road and the road leading into the landfill area, and wells MD9-5, MD9-6 and MD9-7 were aligned west to east along the south side of the gravel road in the fenced landfill area (Figure 3.6). These wells were located to aid in defining shallow subsurface lithology, groundwater flow directions, and water quality at the site.

Groundwater samples were collected from the new wells and existing wells MD9-2 and MD9-3. Well MD9-1 could not be found in the area where it was reportedly installed (WAR, 1984) as shown in Figure 1.9, and it may have been destroyed. Groundwater samples were analyzed for purgeable organics, base/neutral and acid extractable organics, and metals. Sediment and surface water samples were collected at two locations along the drainage ditch south of the landfill. These samples were analyzed for the same parameters as the groundwater samples. Temperature, pH, and specific conductivity of the groundwater and surface water samples were measured at the time of sampling.

A second round of sampling was conducted at Site No. 9 in August, 1987. Samples were collected from four surface water stations and the six groundwater monitoring wells. These samples were analyzed for purgeable organics and base/neutral and acid extractable organics.

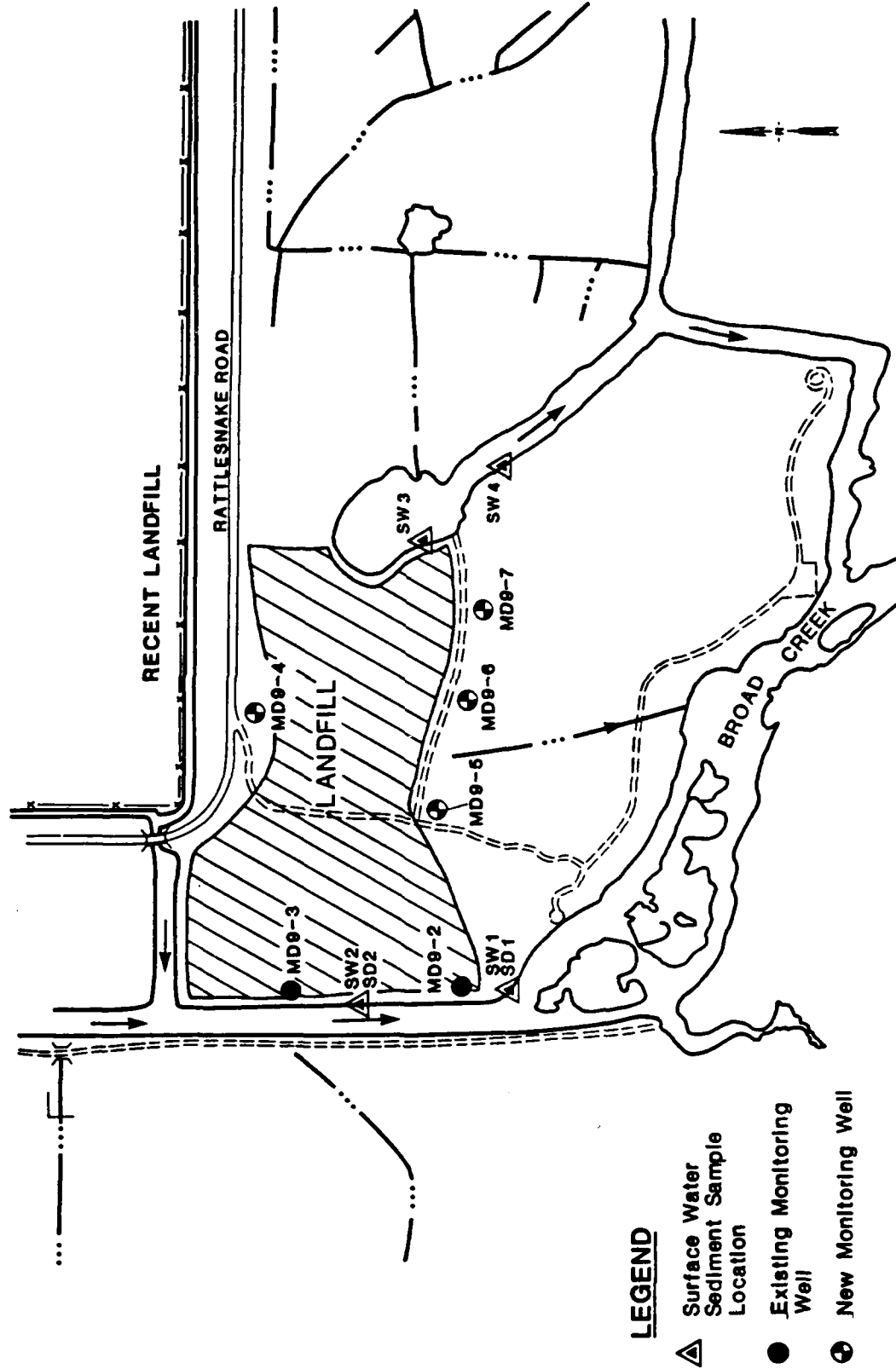
3.9.5 Chemical Munitions Burial Area (Site No. 11)

The old Chemical Munitions Burial Area was reported (CH2M HILL, 1981) as the area across Southshore Road from the old SAC Alert Area, next to the north-south drainage canal (Figure 3.7). A records search was performed to further identify the burial area and the types of waste buried there. The field work at this site included the collection of

FIGURE 3.6

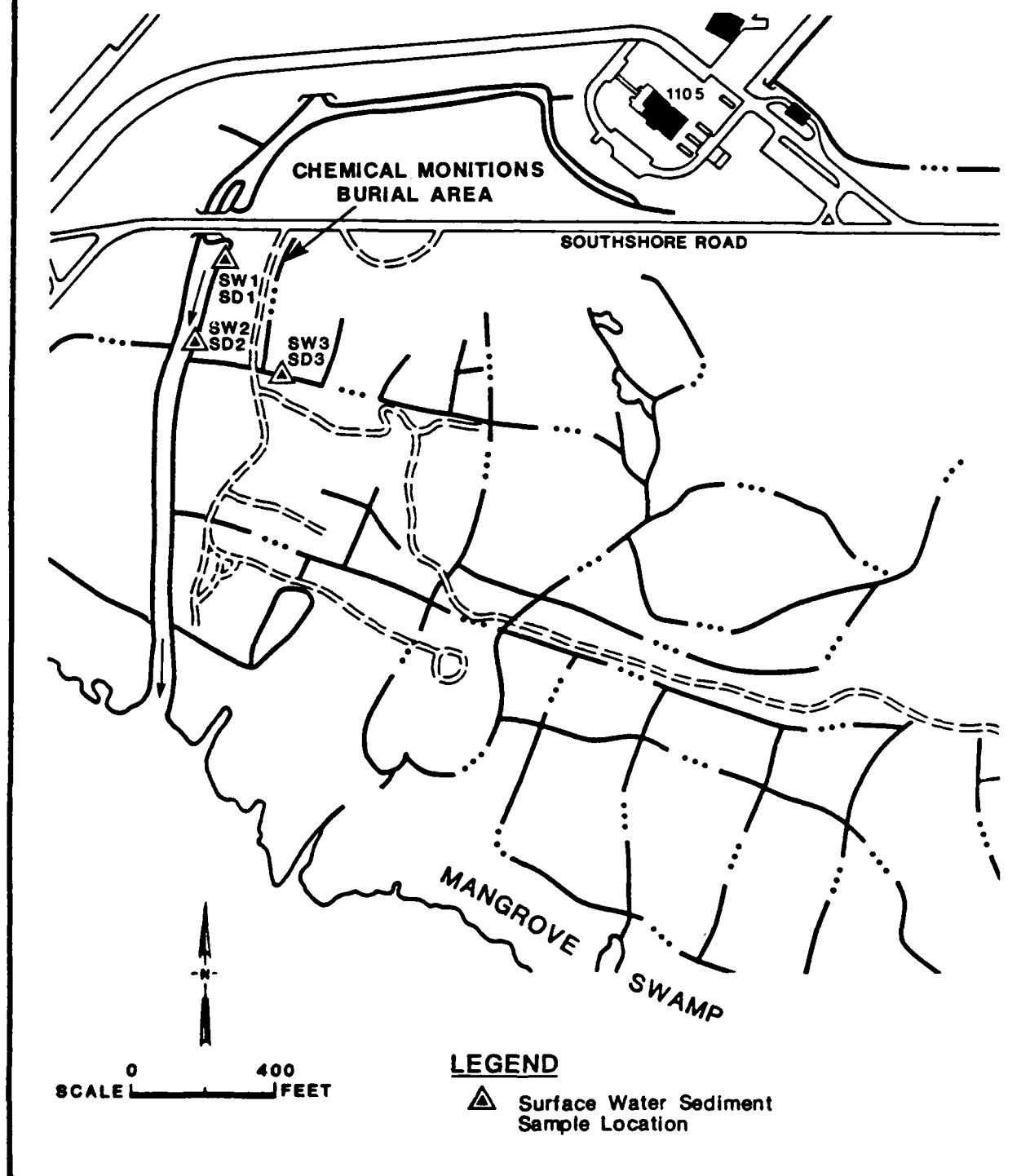
MONITORING STATIONS LOCATION MAP OF SITE 9

MACDILL AFB



MACDILL AFB

MONITORING STATIONS LOCATION MAP OF SITE 11



surface water and sediment samples at three locations in drainage ditches and canals on the site. These samples were analyzed for purgeable organics, base/neutral and acid extractable organics, and metals. Temperature, pH, and specific conductance of the water samples were measured at the time of sampling. A geophysical survey was conducted at this site during August 1987.

3.9.6 Creosote Pit (Site No. 13)

The field program at Site No. 13 included an electrical resistivity (ER) survey, the installation of three monitoring wells, and groundwater sampling. The ER survey was performed to help locate the creosote pit and to qualitatively identify any leachate plumes.

Monitoring wells MD13-1, MD13-2, and MD13-3 were each drilled to a depth of 20 feet. Boring MD13-2A encountered a solution cavity at a depth of 17 to 22 feet. This boring was backfilled with bentonite and neat cement to the surface and a new boring drilled at a distance of approximately 25 feet. This boring was completed as well MD13-2. Well MD13-1 is located north of a water retention pond near North Boundary Road. Well MD13-2 is located approximately 700 feet south of MD13-1. Well MD13-3 is located near the Base Exchange Building, just west of C Street (Figure 3.8). These wells were installed to define shallow, subsurface lithology, groundwater flow directions, and water quality at Site No. 13.

Groundwater samples collected from these wells were analyzed for base/neutral and acid extractable organics. Temperature, pH and specific conductance of the groundwater samples were measured at the time of sampling.

3.9.7 Fuel Tank Farm (Site No. 16)

The field program at Site No. 16 consisted of the collection of sediment and surface water samples at six locations from the drainage ditches near the site. The locations of the sampling stations are given in Figure 3.9. The surface water samples were analyzed for petroleum hydrocarbons, purgeable organics including xylenes, EDB, and lead. Temperature, pH, and specific conductance of the surface water samples were measured at the time of sampling. The sediment samples were analyzed for petroleum hydrocarbons, purgeable organics, and lead.

MACDILL AFB

MONITORING STATIONS LOCATION MAP OF SITE 13

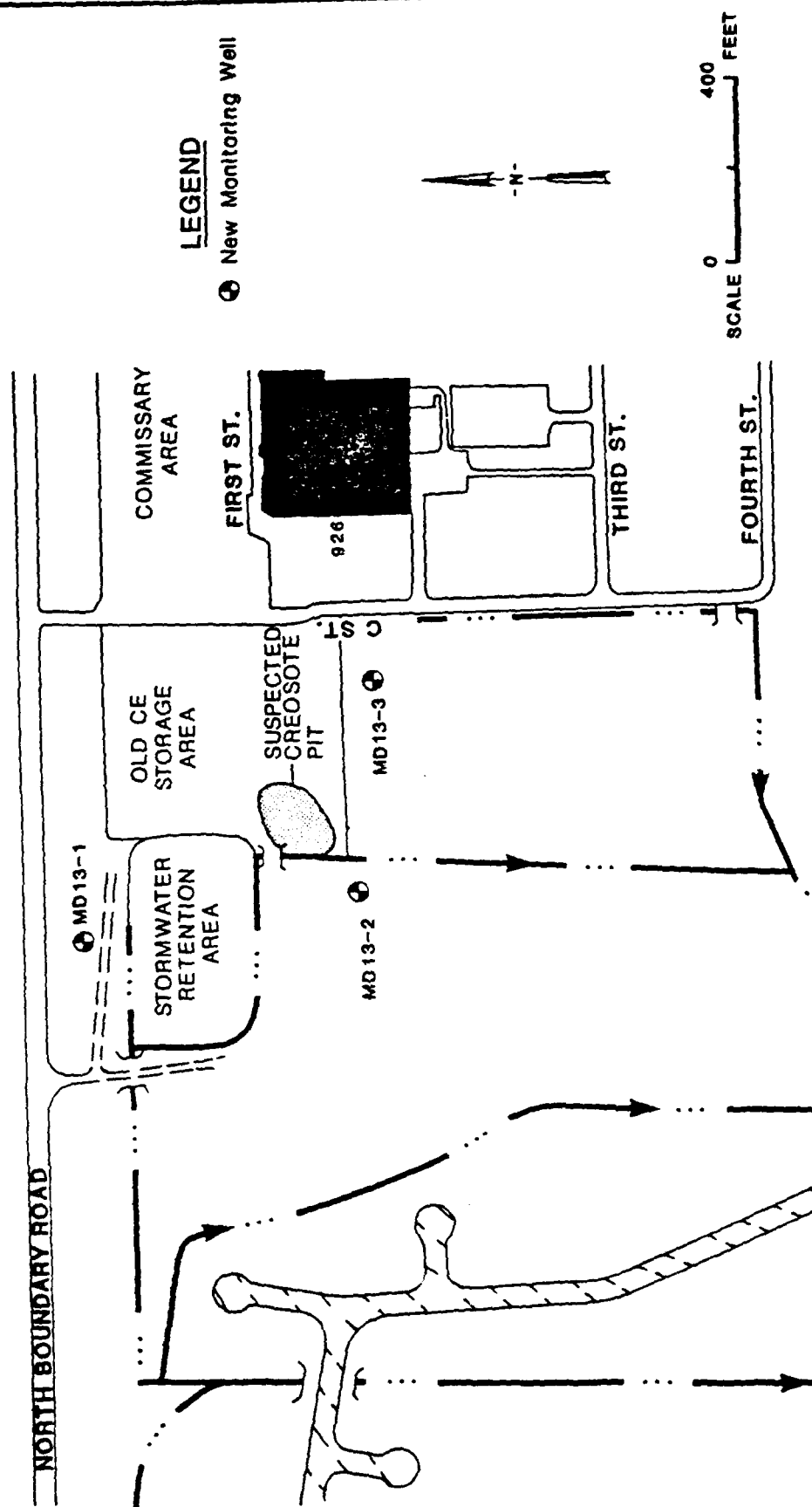


FIGURE 3.8

MACDILL AFB

MONITORING STATIONS LOCATION MAP OF SITE 16

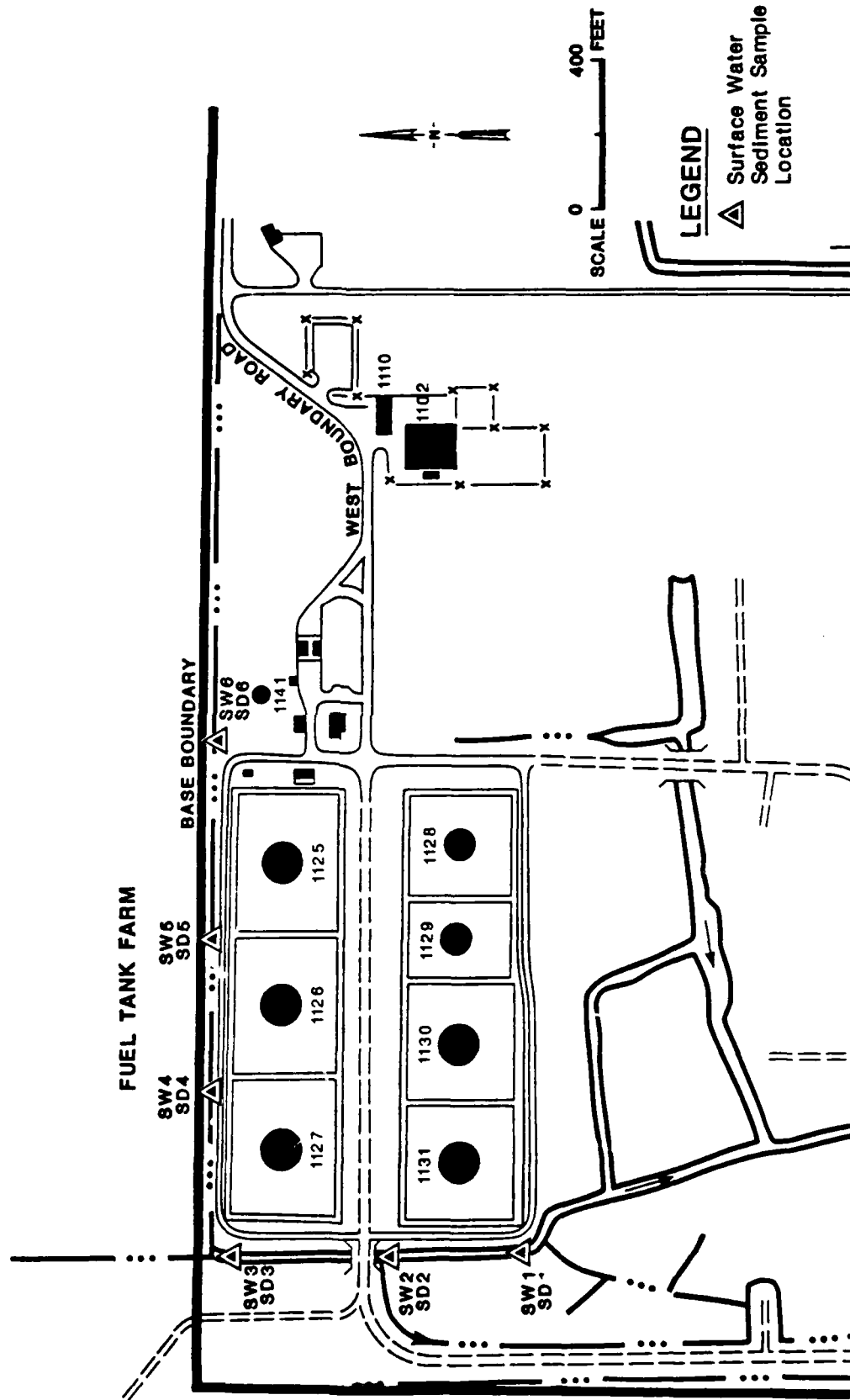


FIGURE 3.9

3.9.8 Drum Storage Area (Site No. 17)

The field program at Site No. 17 included the installation of one upgradient monitoring well, the collection of groundwater samples from the new well and two existing wells, and the collection of three sediment samples and one surface water sample from three locations in the drainage ditch west of the site. Monitoring well MD17-3 was installed to a depth of 20.5 feet north of Building 864 and upgradient of the site (Figure 3.10). Groundwater samples from this well and two existing wells (MD17-1 and MD17-2) were analyzed for purgeable organics, base/neutral and acid extractable organics, lead, cadmium, zinc, and chromium. Three sediment samples and the one surface water sample were collected and were analyzed for the same parameters as the groundwater. Temperature, pH, and specific conductance of the groundwater and surface water samples was measured at the time of sampling.

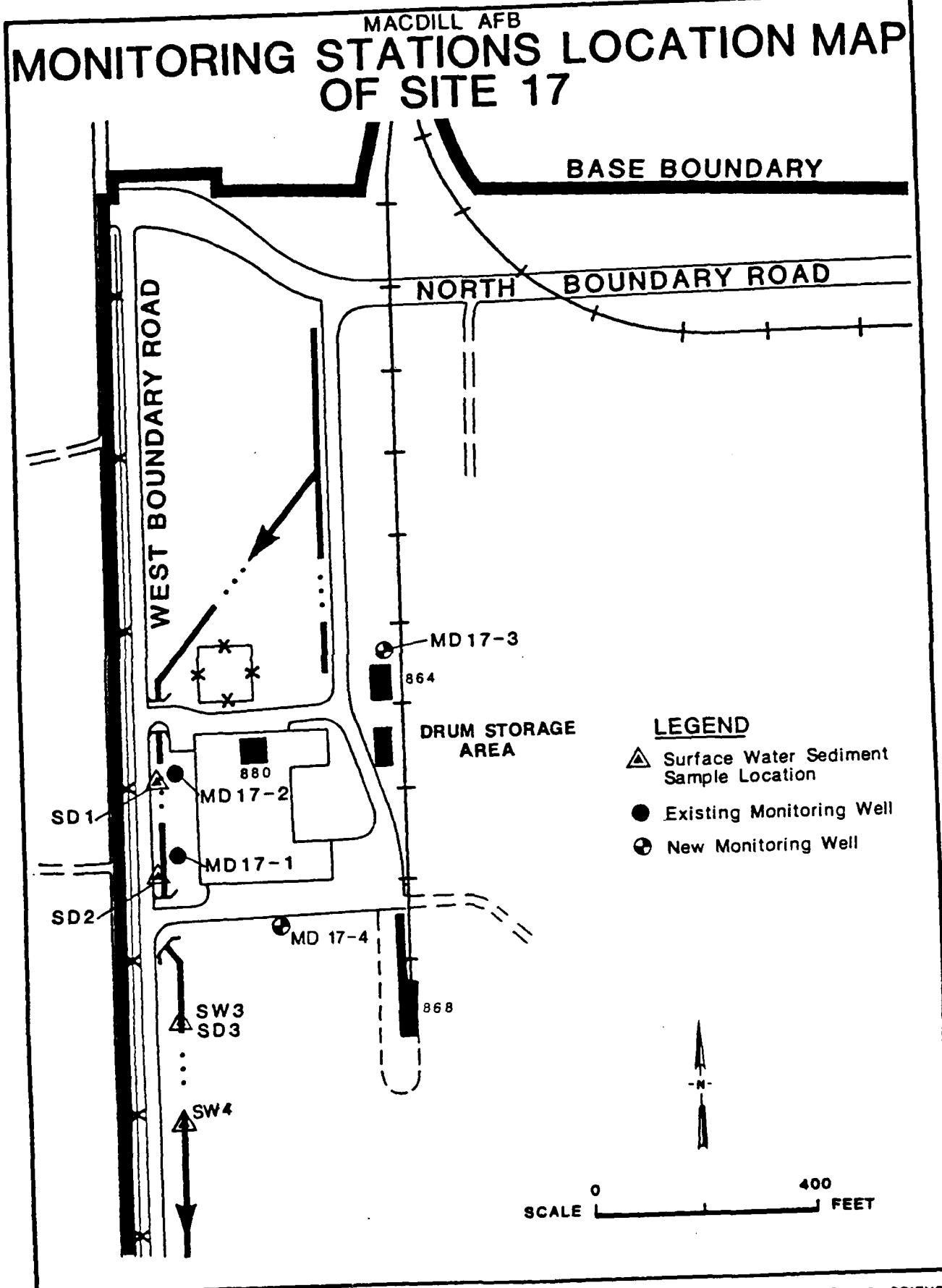
Additional fieldwork was conducted at Site No. 17 during August, 1987, which included the installation of an additional monitoring well, MD17-4, and the collection of two surface water samples and four groundwater samples. The samples were analyzed for purgeable organics and base/neutral and acid extractable organics. The new monitoring well, MD17-4, was installed due south of the site (Figure 3.10).

3.9.9 Fire Training Areas (Site No. 23)

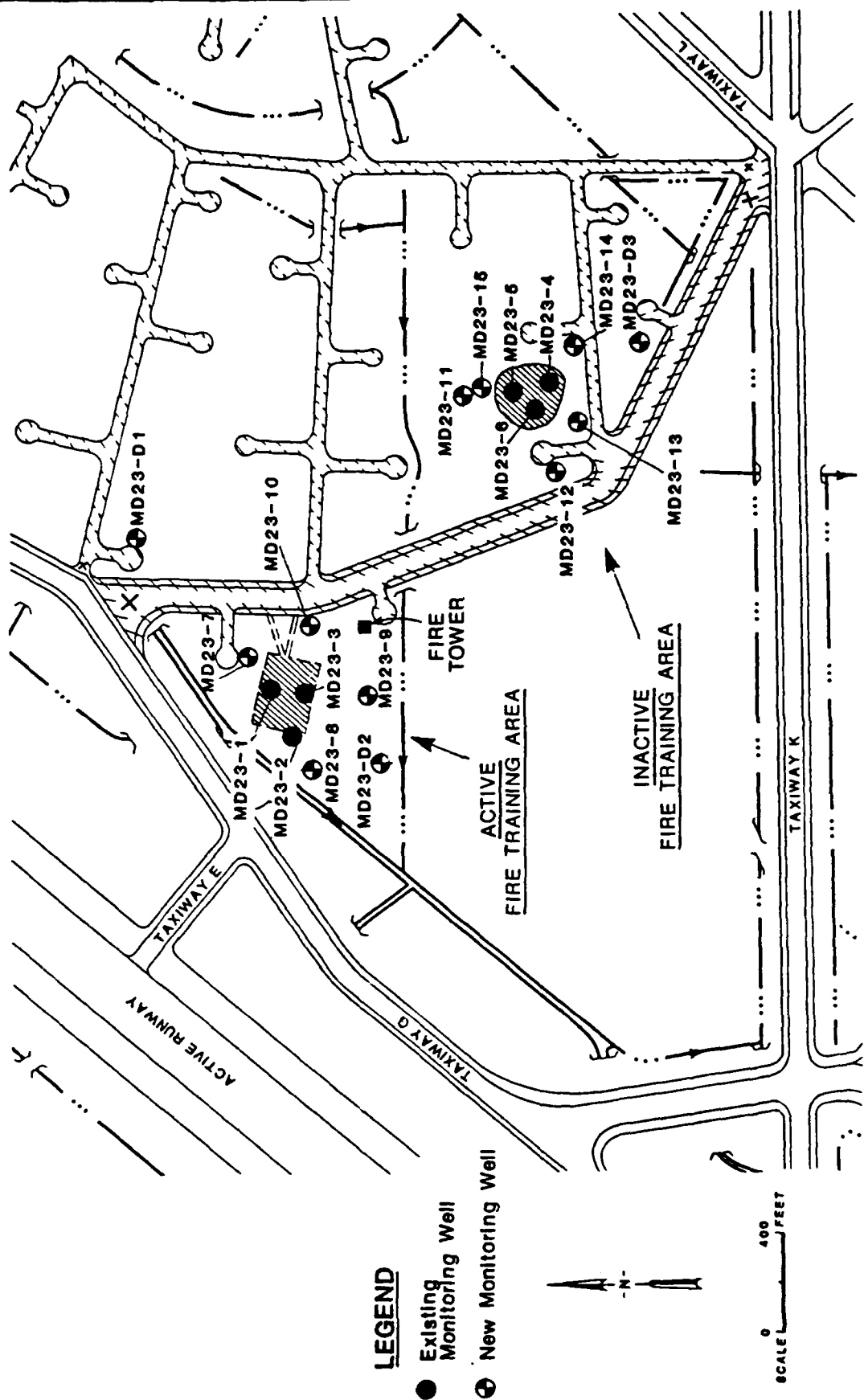
The field program at Site No. 23 included an electrical resistivity (ER) survey, the installation of eleven monitoring wells, installation of one observation well for aquifer testing, an aquifer pumping test, and groundwater sampling. The ER survey was performed to qualitatively identify the extent of any contaminant plumes.

Eight shallow monitoring wells were installed (Figure 3.11). Monitoring wells MD23-7, MD23-8, MD23-9 and MD23-10 are located at the active fire training area and were completed to depths of 15 feet, 15 feet, 21 feet and 14 feet, respectively. Monitoring wells MD23-11, MD23-12, MD23-13, and MD23-14 are located at the inactive fire training area and were completed to depths of 19 feet, 15 feet, 14 feet, and 14 feet, respectively. These wells were installed to define shallow subsurface lithology, to determine groundwater flow directions, and to determine water quality in the shallow aquifer.

FIGURE 3.10



MACDILL AFB MONITORING STATIONS LOCATION MAP OF SITE 23



Three deeper aquifer monitoring wells MD23-D1, MD23-D2 and MD23-D3 were installed, one upgradient and two downgradient from site No. 23 (Figure 3.11). They were drilled to depths of 63 feet, 90 feet, and 57 feet, respectively. These wells were installed to help define groundwater flow directions and water quality in the upper part of the Floridan Aquifer.

Groundwater samples, collected from all eleven of the new wells and all six of the existing wells, were analyzed for purgeable organics, petroleum hydrocarbons, and lead. Temperature, pH, and specific conductance of samples from the wells were measured at the time of sampling.

An aquifer pumping test was performed at the inactive fire training area using well MD23-11 as the pumped well. Well MD23-15 was completed as an observation well at a depth of 14 feet. The results of this test are given in Section 4 and a complete description of the test procedures and raw data are presented as Appendix E.

3.9.10 Old Landfill, Avon Park (Site AP6)

The field program at Avon Park AFR Site AP6 consisted of the installation of one upgradient monitor well and the collection of sediment, surface water, and groundwater samples. Monitoring well AP6-4 was installed to a depth of 20 feet, upgradient of the site, just east of Kissimmee Road (Figure 3.12).

Groundwater samples from the new well and three existing wells (AP6-1, AP6-2 and AP6-3) were analyzed for purgeable organics, base/neutral and acid extractable organics, petroleum hydrocarbons, and metals. Three sediment and surface water sampling stations were located within the rim canal which runs east to west through the site (Figure 3.12). Samples from these locations were analyzed for the same parameters as the groundwater samples. Temperature, pH, and specific conductance of the groundwater and surface water samples were measured at the time of sampling.

3.9.11 Recent Landfill, Avon Park (Site AP7)

The field program at Site AP7 included the installation of one upgradient monitoring well and the collection of groundwater samples. Monitoring well AP7-4 was installed to a depth of 20 feet upgradient of the site, across the taxiway from the southern corner of the landfill area (Figure 3.13).

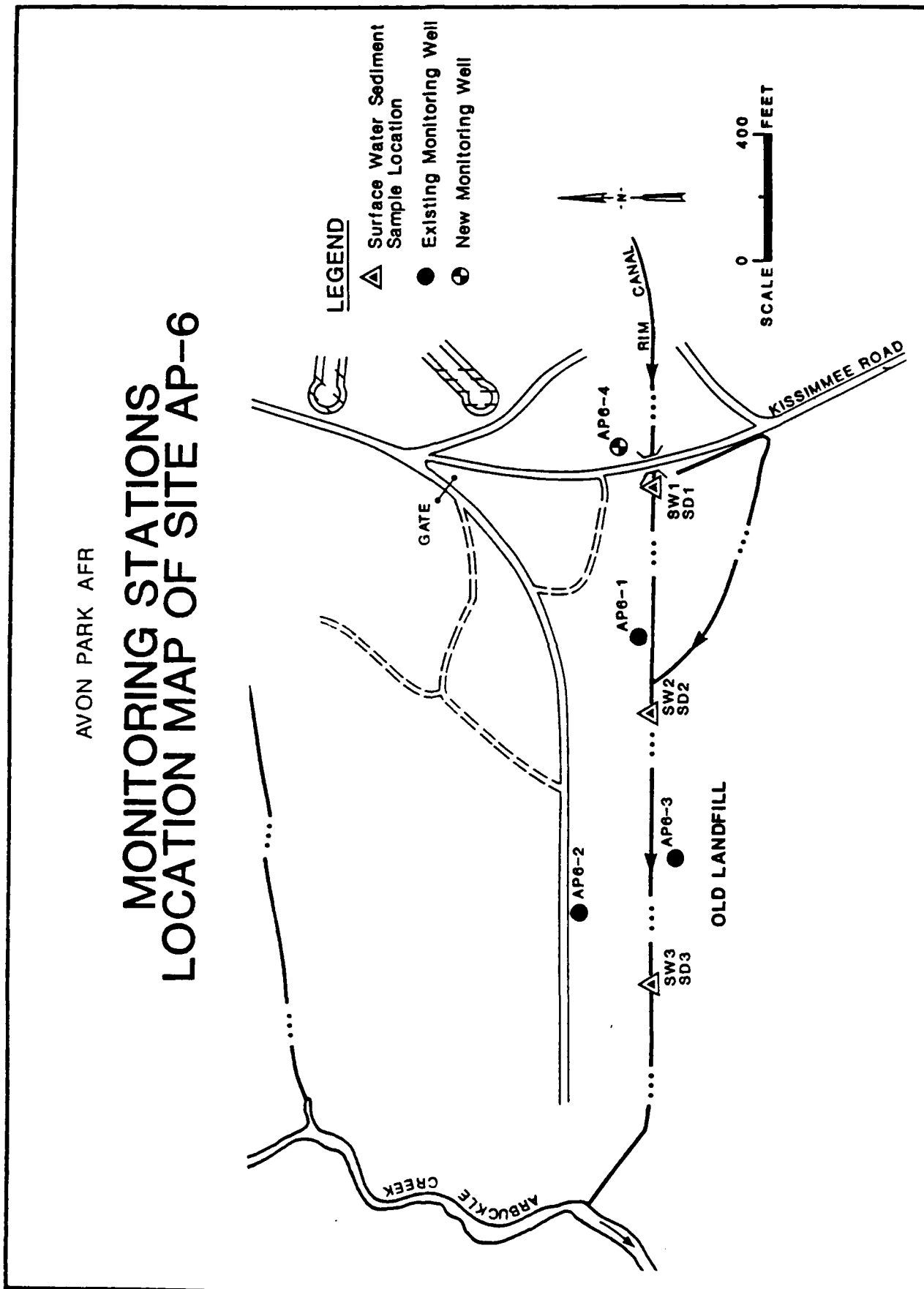
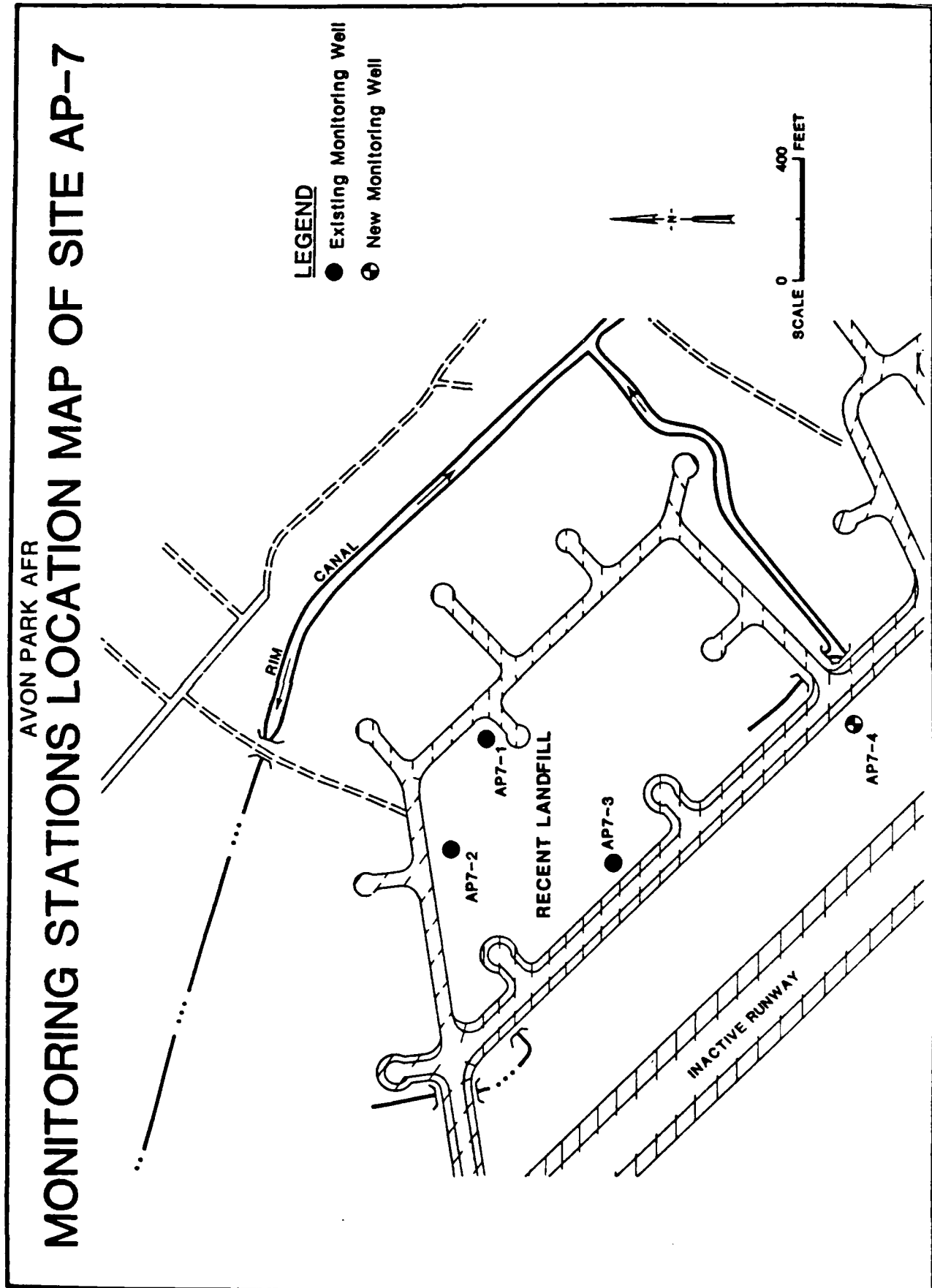


FIGURE 3.13



Groundwater samples collected from the new well and the three existing wells (AP7-1, AP7-2 and AP7-3) were analyzed for purgeable organics, base/neutral and acid extractable organics, petroleum hydrocarbons, and metals. Temperature, pH, and specific conductivity of the groundwater samples were measured at the time of sampling.

3.9.12 Army Test Area, Avon Park (Site AP9)

Soil samples were collected at ten locations within Site AP9, from the upper six inches of soil. The soils sampling locations are shown on Figure 3.14. The soil samples were analyzed for 2,3,7,8-TCDD (dioxin) and herbicides.

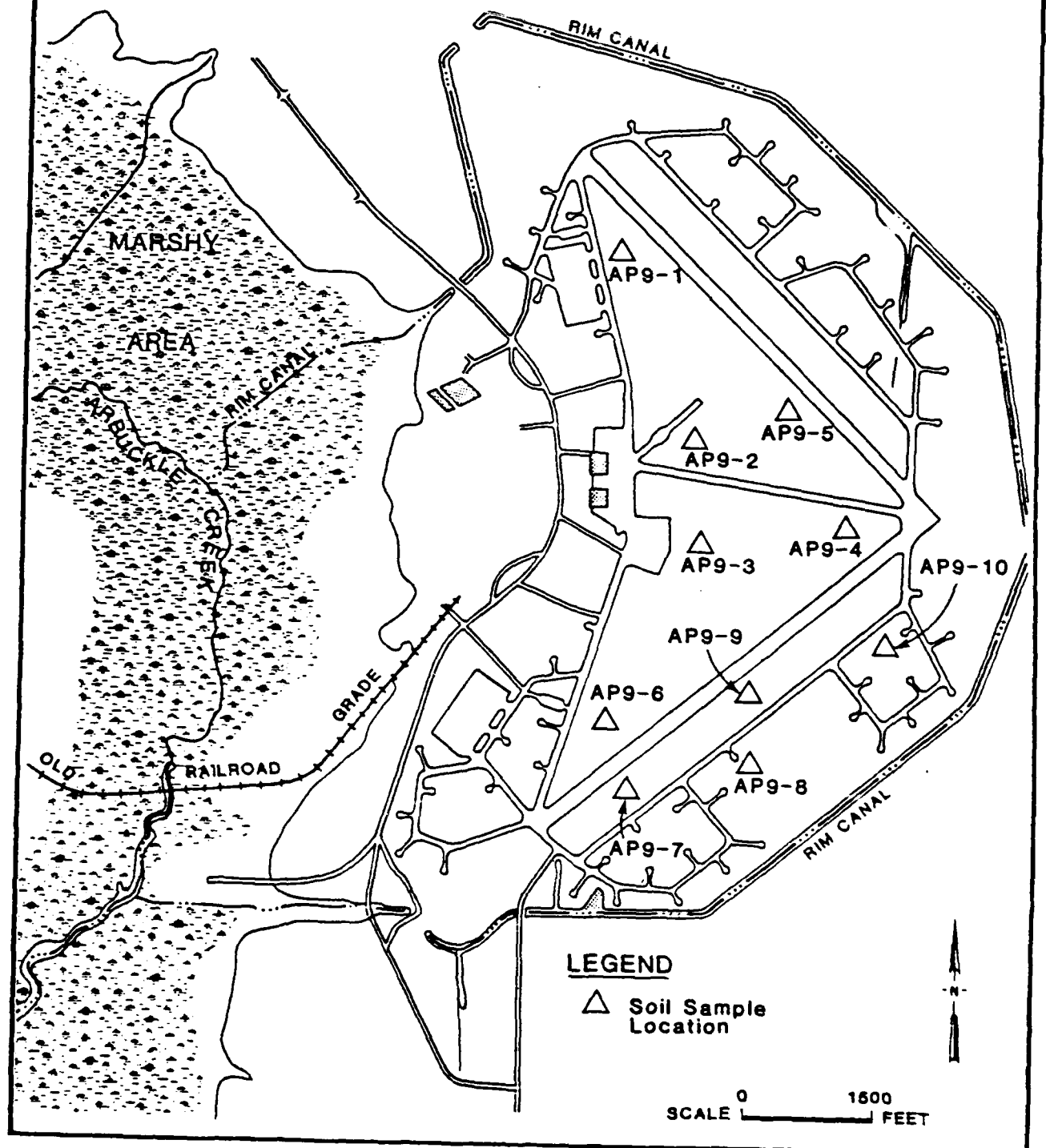
3.10 SCHEDULE OF FIELD ACTIVITIES

The initial field program was conducted from August to November 1986. Geophysical studies were conducted between 6 August 1986 and 19 August 1986. Monitoring well installation and drilling activities were conducted between 15 September 1986 and 7 October 1986. The monitoring wells were sampled between 9 October 1986 and 30 October 1986. Surface sediment, and soil samples were collected between 19 October 1986 and 30 October 1986. The aquifer pumping test at site No. 23 was performed during the period from 15 October to 17 October 1986.

A second field investigation was conducted which included the installation of a new monitoring well at Site B and a new monitoring well at Site 17, a geophysical survey at Site 11, and the collection of surface water and groundwater samples at Sites B, 3, 5-8, 9, and 17. This effort was conducted in August of 1987.

AVON PARK AFR

MONITORING STATIONS LOCATION MAP OF SITE AP-9



SECTION 4
RESULTS AND SIGNIFICANCE OF FINDINGS

SECTION 4

RESULTS AND SIGNIFICANCE OF FINDINGS

This section presents the results of the field investigation programs described in Section 3, and both general and site-specific discussions of the significance of the findings at MacDill AFB and Avon Park AFR. Subsection 4.1 presents a site-by-site summary of field observations, results of the geophysical surveys, drilling and well installation program results, aquifer pumping test results, and analytical results for groundwater, surface water, sediment, and soil samples. Subsection 4.2 is the discussion of the criteria used to determine the significance of these results including applicable federal and State of Florida standards and guidelines. The significance of the findings at the individual sites is presented in subsection 4.3.

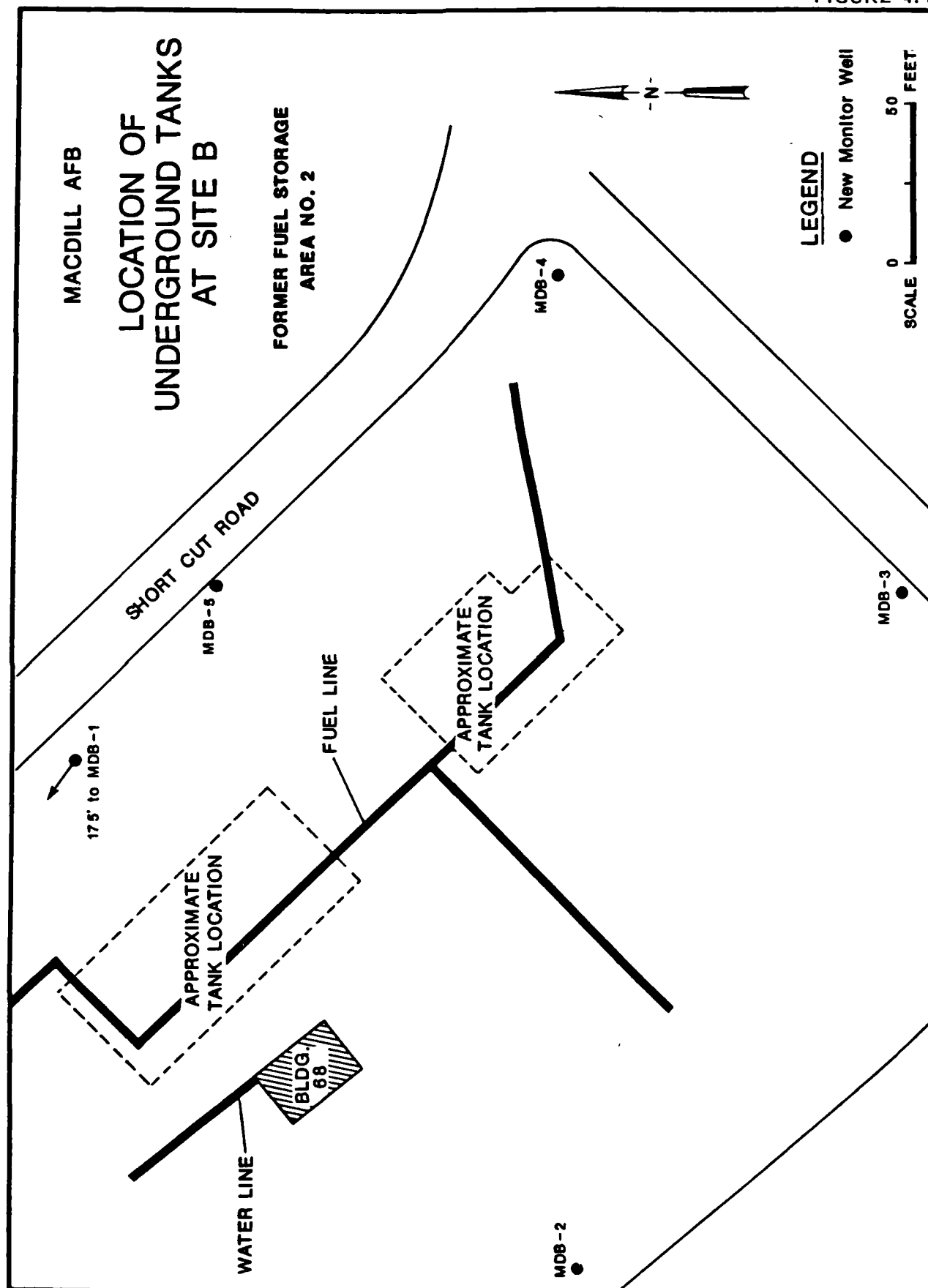
The raw data from which the results in this section were derived are presented as several appendices to this report. The Geophysical Survey Report is Appendix F, and the Aquifer Pumping Test Data are presented as Appendix E. Analytical data are presented in Appendix J, with Quality Control/Quality Assurance Data in Appendix I. The field boring logs, well completion reports, and well diagrams are given in Appendix D.

4.1 SITE-SPECIFIC RESULTS OF THE FIELD INVESTIGATION PROGRAM

4.1.1 Former Fuel Storage Area No. 2 (Site B)

The initial field investigation at Site B included magnetic and electrical resistivity (ER) surveys and the installation and sampling of four monitoring wells. The magnetic survey identified the location of the old buried fuel tanks and pipelines as the same area as indicated on utilities drawings acquired from Base Civil Engineering. The approximate locations of the buried tanks and pipelines are shown in Figure 4.1. The ER survey consisted of one 60 foot sounding and profiles at 5,

FIGURE 4.1



10, 20, and 30 foot spacings. The sounding data were not conclusive in differentiating between stratigraphic units at this site. The ER profiles showed low resistivity readings in the south and southwest portions of the site, where wells MDB-2 and MDB-3 were later installed.

Four monitoring wells were installed at Site B (Figure 4.2) ranging in depth from 14 to 17 feet. All were completed in the undifferentiated sandy materials (sands, silty sands, clayey sands) of the surficial aquifer. Neither visual examination of samples and cuttings or monitoring with the HNU organic vapor detector during drilling indicated the presence of any contaminants.

Groundwater levels were measured during October 1986 and again at high and low tides during January and August, 1987. Groundwater elevations (in feet Mean Sea Level [MSL]) for each event are given below:

<u>October 1986</u>		<u>January 1987</u>		<u>August 1987</u>	
		<u>High Tide</u>	<u>Low Tide</u>	<u>High Tide</u>	<u>Low Tide</u>
MDB-1	3.25	2.91	2.87	3.01	3.02
MDB-2	3.79	3.62	3.53	3.54	3.55
MDB-3	3.97	3.31	3.14	3.15	3.11
MDB-4	3.20	2.69	2.59	2.68	2.69
MDB-5	--	--	--	2.62	2.61

Based on these measurements, the general groundwater flow direction at Site B is shown on Figure 4.2. Groundwater is influenced by tidal changes as shown above. Extremely high or low tides during storms and spring tides will cause even greater disruptions to flow directions and gradients.

Groundwater samples were collected from all four wells at site B during the first field sampling in October 1986. The samples were analyzed for purgeable halocarbons, aromatic volatile organics (including xylenes), EDB, petroleum hydrocarbons, and lead. Analytical results and field measurements for Site B are given in Table 4.1. In well MDB-2, chloroform was found and confirmed at 1.4 ug/L, ethylbenzene at 12 ug/L, and xylene at 1.0 ug/L. No purgeable halocarbons or aromatics were found in the other groundwater samples. Lead was found only in water from well MDB-3 at 0.01 mg/L. Petroleum hydrocarbons were

FIGURE 4.2

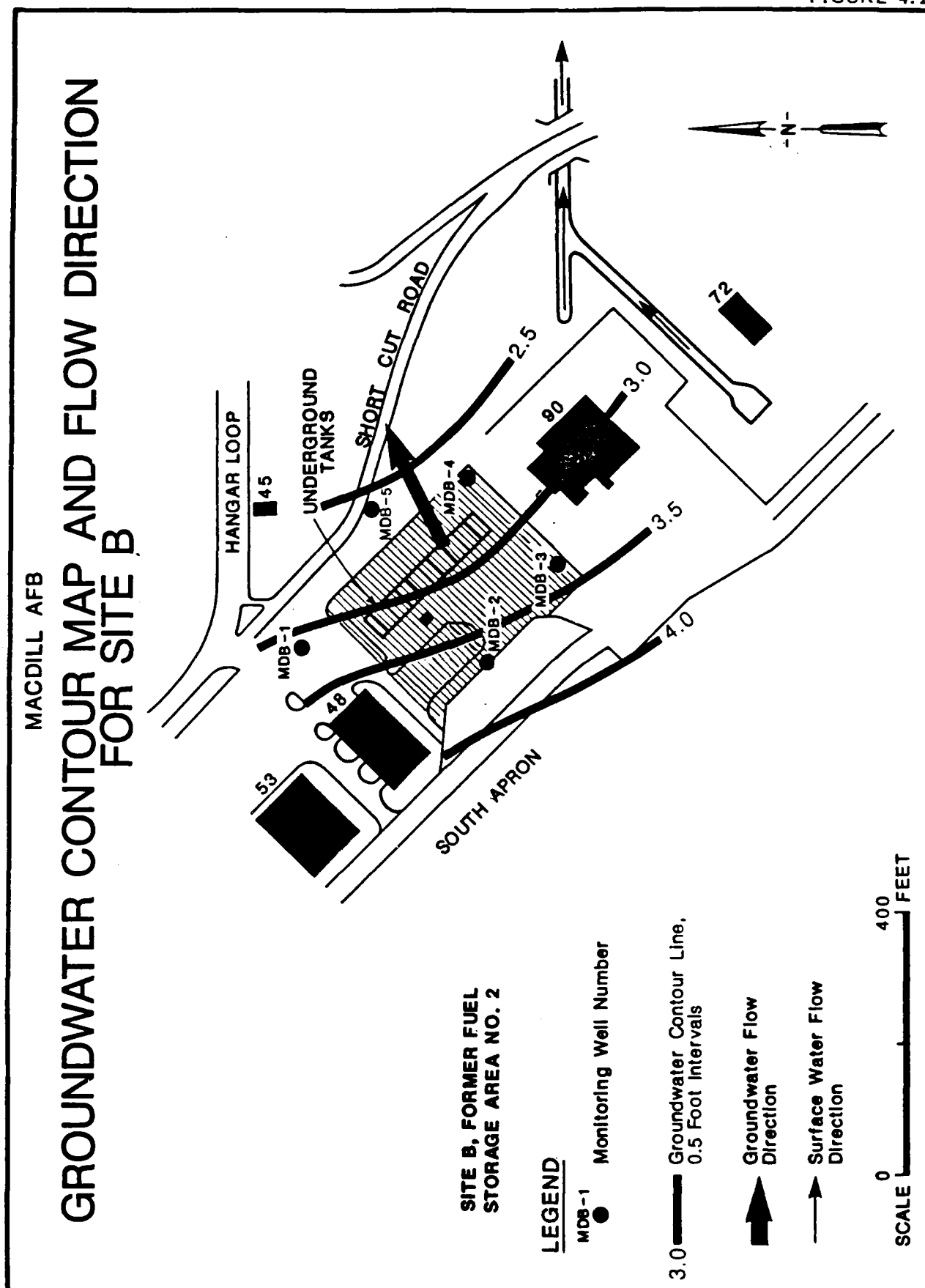


TABLE 4.1
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR GROUNDWATER SAMPLES
FROM SITE B

PART A: LABORATORY RESULTS

Sample Identifier	Purgeable Halocarbons (E601) (ug/L)	Aromatic Volatile Organics (with Xylene) (SW5030/8070) (ug/L)	1,2-Dibromoethane (E502.1) (ug/L)	Petroleum Hydrocarbons (E418.1) (mg/L)	Lead (E239.2) (mg/L)
<u>First Round Samples, October 1986</u>					
B MDR-1 GW ES	ND	ND	ND	ND	ND
B MDR-2 GW ES	Chloroform-1.4	Ethylbenzene - 12 Xylene - 1.0	ND	ND	ND
B MDR-3 GW ES	ND	ND	ND	ND	0.01
B MDR-4 GW ES	ND	ND	ND	0.50	ND
B MDR-5 GW ES	ND	ND	ND	ND	ND
(Duplicate of MDR-4)					
<u>Second Round Samples, August 1987</u>					
MDR-1 GW ES	Methylene Chloride - 0.62	ND	--	0.54	ND
MDR-2 GW ES	Chlorobenzene - 1.1	Ethylbenzene - 5.3	--	0.98	ND
MDR-3 GW ES	Methylene Chloride - 0.72	ND	--	0.54	ND
MDR-4 GW ES	Methylene Chloride - 0.52	ND	--	0.45	ND
MDR-5 GW ES	Methylene Chloride - 0.71	ND	--	0.36	ND
MDR-6 GW ES	Chloromethane - 2.6	ND	ND	0.45	ND
(Duplicate of MDR-5)					
ND - Not Detected					

PART B: FIELD MEASUREMENTS

	Site B	pH	Conductivity (umhos/cm)	Temperature °C
<u>October 1986</u>				
B MDR-1 GW ES		6.5	440	29
B MDR-2 GW ES		6.6	399	29.5
B MDR-3 GW ES		6.6	303	30
B MDR-4 GW ES		6.5	434	30
<u>August 1987</u>				
MDR-1 GW ES		--	500	29
MDR-2 GW ES		--	300	29
MDR-3 GW ES		--	300	29
MDR-4 GW ES		--	250	29
MDR-5 GW ES		--	350	31

found in water from well MDB-4 at 0.50 mg/L. Field analyses showed pH, conductivity, and temperature were approximately the same in all four wells at Site B.

During August, 1987, a second round of field work was conducted at Site B. This work included the installation of one additional monitoring well, the collection and analysis of groundwater samples from all five monitoring wells, and the measurement of water levels at high and low tide events. The new monitoring well, MDB-5, was installed along Short Cut Road, east-northeast of the abandoned underground tanks (Figure 4.2). This well was completed in sandy materials in the surficial aquifer. This location is downgradient of the site, based upon water levels measured during the first field effort. The results of high and low tide water level measurement (shown above) indicate a flow direction towards the east-northeast, which is consistent with previous groundwater measurements.

Groundwater samples were collected from the five wells at Site B during August 1987. These samples were analyzed for purgeable halocarbons, aromatic volatile organics (including xylenes), petroleum hydrocarbons and lead. Analytical results and field measurements for the second round samples at Site B are included in Table 4.1. In well MDB-2, chlorobenzene was confirmed at 1.1 ug/L and ethylbenzene at 5.3 ug/L. Methylene chloride was reported in the analyses for wells MDB-1, -2, -3, -4 and -5, all at concentrations less than 1 ug/L. Chloromethane was reported for well MDB-5 at 2.6 ug/L. No other purgeable halocarbons or aromatics were found. Petroleum hydrocarbons were detected in all samples at trace levels (0.36 to 0.98 mg/L). Conductivity ranged from 250 to 500 umhos/cm and temperature ranged from 29°C to 31°C in these groundwater samples.

4.1.2 Landfill at Dog Kennel (Site No. 3)

The initial field investigation at Site No. 3 included an ER survey, the installation of one monitoring well, groundwater sampling, and the collection and analysis of surface water and sediment samples.

The ER survey consisted of soundings and profiles. A 60-foot sounding was performed north of the landfill area along Southshore Road. The sounding data showed three stratigraphic units which correlate with the data from drilling log MD3-6. The profile data showed an area of

low resistivity in the south-southwest portion of the site, which was probably due to the high conductivity of brackish water introduced by the drainage ditches.

One monitoring well, MD3-6, was installed upgradient at Site No. 3. Boring log data for MD3-6 showed sandy materials overlying clayey materials. Visual examination of cuttings and split spoon samples, and monitoring with an HNU organic vapor detector, did not reveal the presence of any contaminants.

Groundwater levels were measured in October 1986 and in August 1987 and are given below (in feet, MSL) for all wells at Site No. 3. Based upon these water level measurements, groundwater flow direction is to the south-southwest (Figure 4.3).

<u>October 1986</u>		<u>August 1987</u>	
		<u>High Tide</u>	<u>Low Tide</u>
MD3-1	1.63	1.26	1.28
MD3-2	1.58	0.97	0.89
MD3-3	2.48	1.88	1.95
MD3-6	3.56	2.59	2.64

In the first field sampling, four groundwater and five surface water samples were analyzed for purgeable halocarbons, purgeable aromatics, base/neutral and acid extractable organics, and metals. All analytical results including field measurements for water samples at Site No. 3 are given in Table 4.2. Two base/neutral and acid extractable compounds were reported for all four groundwater samples at Site No. 3. Bis(2-ethylhexyl)phthalate was reported at levels ranging from 45 ug/L to 740 ug/L and di-n-butyl phthalate was found at levels ranging from 53 ug/L to 67 ug/L. No other organic contaminants were found in groundwater samples, and no organic compounds were detected in surface water samples. The metals scan detected the presence of various metals in all water samples (Table 4.2). As indicated by high sodium and magnesium levels, and conductivity values ranging from 8,100 umhos/cm to 16,640 umhos/cm in all but one sample, most of the groundwater and surface water at Site No. 3 is directly affected by brackish water in the tidally influenced ditches.

MACDILL AFB GROUNDWATER CONTOUR MAP AND FLOW DIRECTION FOR SITE 3

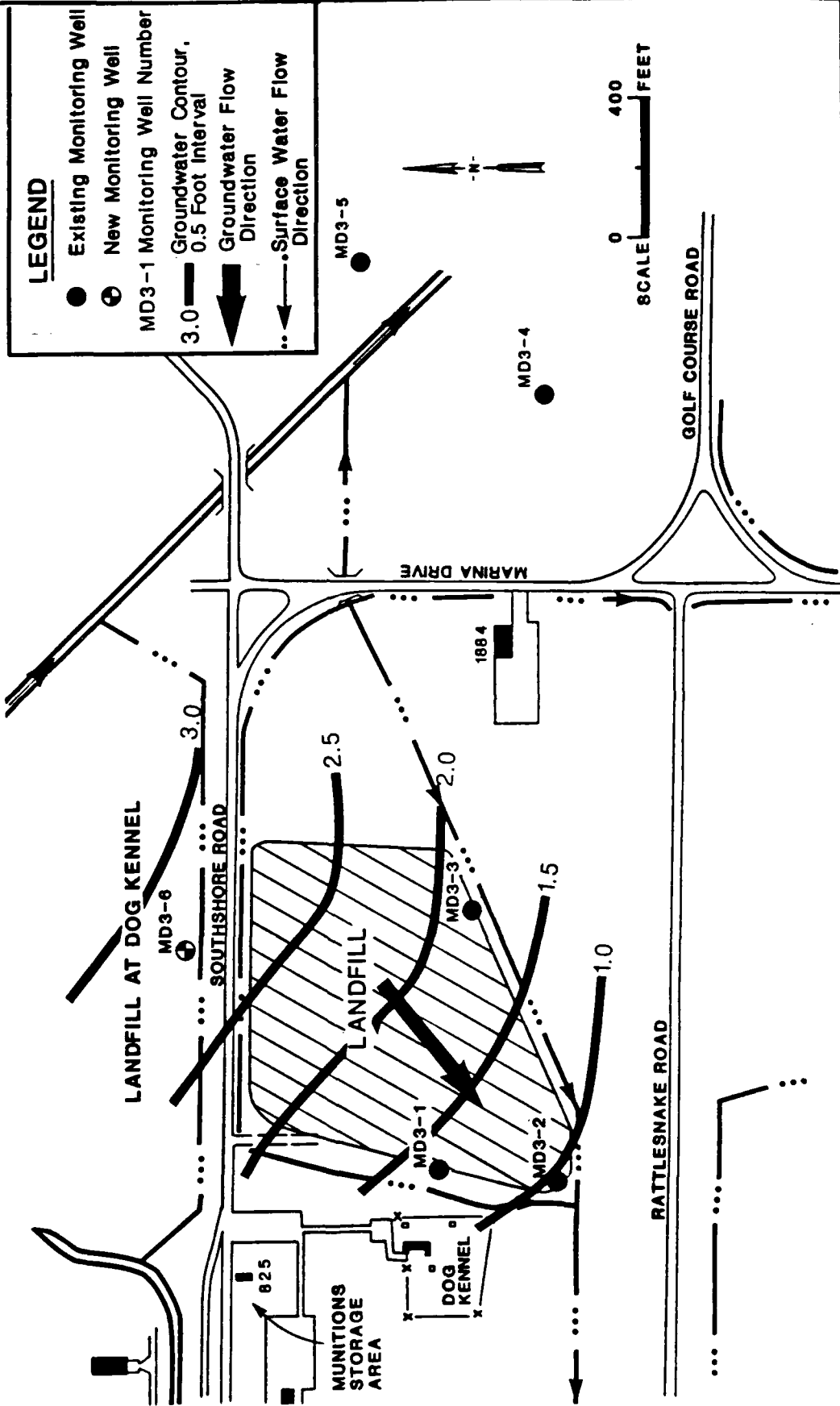


FIGURE 4.3

TABLE 4.2
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR GROUNDWATER AND SURFACE WATER SAMPLES
FROM SITE NO. 3

PART A: LABORATORY RESULTS

Sample Identifier	Purgeable Halocarbons (E601) (ug/L)	Purgeable Aromatics (E602) (ug/L)	Acid Extractable Organics (E625) (ug/L)	Base/Neutral and Acid Extractable Organics (E625) (ug/L)	Metals Scan (E200.7/245.1) ^{b,e} (mg/L)
<u>First Round Samples, October 1986</u>					
DK MD3-1 GW ES	ND	ND ^f	Bis(2-ethylhexyl) phthalate - 250	Aluminum - 6.7 ^a Arsenic - 0.01 ^a Barium - 0.18 Boron - 0.9 Calcium - 580 Iron - 6.6 ^a Lead - 0.01 ^a	Magnesium - 430 Manganese - 0.08 Molybdenum - 0.01 Potassium - 120 Selenium - 0.39 ^a Silica - 24 Sodium - 3600
DK MD3-2 GW ES	ND	ND ^f	Bis(2-ethylhexyl) phthalate - 740 Di-n-butyl phthalate - 67	Aluminum - 5.6 ^a Arsenic - 0.05 ^a Barium - 0.20 Boron - 1.9 Calcium - 550 Iron - 24 Lead - 0.04 ^a	Magnesium - 680 Manganese - 0.05 Potassium - 190 Selenium - 0.47 ^a Silica - 17 Sodium - 7000
DK MD3-3 GW ES	ND	ND ^f	Bis(2-ethylhexyl) phthalate - 380 Di-n-butyl phthalate - 54	Aluminum - 3.5 ^d Arsenic - 0.04 ^{a,d} Barium - 0.07 ^d Boron - 0.40 ^d Calcium - 410 ^d Iron - 23 ^d Lead - 0.01 ^{a,d}	Magnesium - 160 ^d Manganese - 0.07 ^d Potassium - 41 ^d Selenium - 0.18 ^{a,d} Silica - 13 ^d Sodium - 1400 ^d
DK MD3-6 GW ES	ND	ND ^f	Bis(2-ethylhexyl) phthalate - 410 Di-n-butyl phthalate - 54	Aluminum - 43 Arsenic - 0.03 Barium - 0.10 Boron - 0.10 Calcium - 200 Iron - 3.1	Lead - 0.01 Magnesium - 23 Potassium - 7.4 Silica - 55 Sodium - 120 Vanadium - 0.15
DK MD3-7 GW (Duplicate of MD3-1 GW)	ND	ND ^f	Bis(2-ethylhexyl) phthalate - 240 Di-n-butyl phthalate - 34	Aluminum - 6.7 ^a Arsenic - 0.01 ^a Barium - 0.20 Boron - 1.1 Calcium - 580 Iron - 6.4 Lead - 0.03 ^a	Magnesium - 520 Manganese - 0.09 Potassium - 140 Selenium - 0.46 ^a Silica - 17 Sodium - 4300

TABLE 4.2 (cont.)
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR GROUNDWATER AND SURFACE WATER SAMPLES
FROM SITE NO. 3

PART A: LABORATORY RESULTS (Continued)

Sample Identifier	Purgeable Halocarbons (E601) (ug/L)	Purgeable Aromatics (E602) (ug/L)	Acid Extractable Organics (E625) (ug/L)	Base/Neutral and Acid Extractable Organics (E625) (ug/L)	Metals Scan (E200.7/245.1) ^{b,e} (ug/L)
DK MD3-SW1 ES	ND	ND ^f	ND	Aluminum - 0.25 Arsenic - 0.01 Boron - 1.1 Calcium - 280 Iron - 0.45	Magnesium - 610 Potassium - 100 Selenium - 0.07 ^g Silica - 3.1 Sodium - 4000
DK MD3-SW2 ES	ND	ND	ND	Arsenic - 0.01 Boron - 1.0 Calcium - 260 Iron - 0.28 Magnesium - 420	Molybdenum - 0.01 Potassium - 98 Selenium - 0.33 ^a Silica - 2.1 Sodium - 3100
DK MD3-SW3 ES	ND	ND	ND	Arsenic - 0.01 Boron - 0.90 Calcium - 260 Iron - 0.30 Magnesium - 380	Potassium - 87 ^a Selenium - 0.28 ^a Silica - 2.0 Sodium - 2700
DK MD3-SW4 ES	ND	ND	ND	Aluminum - 0.28 Arsenic - 0.01 Boron - 0.50 Calcium - 200	Magnesium - 210 Potassium - 70 Selenium - 0.08 ^a Silica - 4.2 Sodium - 1800
DK MD3-SW5 ES	ND	ND	ND	Aluminum - 0.24 Arsenic - 0.01 Boron - 0.72 Calcium - 190 Iron - 0.33	Lead - 0.01 Magnesium - 310 Potassium - 66 ^a Selenium - 0.22 ^a Silica - 2.4 Sodium - 2100

TABLE 4.2 (cont.)
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR GROUNDWATER AND SURFACE WATER SAMPLES
FROM SITE NO. 3

PART A: LABORATORY RESULTS (Continued)

Sample Identifier	Purgeable Halocarbons (E601) (ug/L)	Purgeable Aromatics (E602) (ug/L)	Acid Extractable Organics (E625) (ug/L)	Base/Neutral and Acid Extractable Organics (E625) (ug/L)	Metals Scan (E200.7/245.1) ^{b,e} (mg/L)
Second Round Samples, August 1987					
MD3-1 GW ES	--	--	ND	ND	--
MD3-2 GW ES	--	--	ND	ND	--
MD3-3 GW ES	--	--	ND	ND	--
MD3-6 GW ES	--	--	ND	ND	--
MD3-SW1 ES	--	--	ND	ND	--
MD3-SW2 ES	--	--	ND	ND	--
MD3-SW3 ES	--	--	ND	ND	--
MD3-SW4 ES	--	--	ND	ND	--
MD3-SW5 ES	--	--	ND	ND	--

ND - Not detected.

a - The high salinity content of the sample was suspected of causing a positive interference during analysis of the metals indicated.

b - Metals scan included metals and detection limits given in Table 1.2.

c - Average of analyses of field sample and an internal duplicate (QC) sample.

d - To meet the target detection limits, five metals were analyzed by graphite furnace AAS instead of ICPES: As(E206.2), Sb(E204.2), Se(E270.2), Pb(E239.2), Mo(E246.2).

e - Method SW5030/8020 was used to analyze this sample instead of Method E602.

TABLE 4.2 (cont.)
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR GROUNDWATER AND SURFACE WATER SAMPLES
FROM SITE NO. 3

PART B: FIELD MEASUREMENTS

	Site 3	pH	Conductivity (umhos/cm)	Temperature (°C)
October 1986	DK MD3-1 GW ES	6.5	8,800	28
	DK MD3-2 GW ES	6.4	10,000	28
	DK MD3-3 GW ES	6.6	8,100	28
	DK MD3-6 GW ES	6.2	1,113	29
	DK MD3-SW1 ES	7.4	15,380	23
	DK MD3-SW2 ES	7.9	16,640	26
	DK MD3-SW3 ES	8.1	15,400	28
	DK MD3-SW4 ES	6.8	11,560	28
	DK MD3-SW5 ES	8.5	12,230	28
August 1987	MD3-1 GW ES	6.5	12,000	28
	MD3-2 GW ES	6.0	>20,000	28
	MD3-3 GW ES	--	3,500	26
	MD3-6 GW ES	5.6	950	28
	MD3-SW1 ES	6.9	1,800	30
	MD3-SW2 ES	--	10,600	30
	MD3-SW3 ES	--	7,500	30
	MD3-SW4 ES	--	3,200	30
	MD3-SW5 ES	5.4	1,900	31

Sediments were collected from seven locations at Site No. 3 (Figure 3.4) and analyzed for volatile organics, semivolatile organics, and EP toxicity metals. Table 4.3 gives the results of chemical analyses of sediment samples from Site No. 3. Arsenic EP toxicity was reported at 0.01 mg/L at location SD-3 and at 0.03 mg/L at location SD-6. Selenium EP toxicity was reported at 0.01 mg/L at location SD-4 and at 0.02 mg/L at location SD-6. No other metals or organic compounds were detected in the sediment samples.

A second field investigation was conducted at Site No. 3 in August 1987, which consisted of the collection and analysis of groundwater and surface water samples and measurement of water levels in the four monitoring wells at high tide and low tide events. The four monitoring wells, MD3-1, MD3-2, MD3-3 and MD3-6, and surface water stations MD3-SW1, MD3-SW2, MD3-SW3, MD3-SW4 and MD3-SW5 were sampled and analyzed for base/neutral and acid extractable organics. No compounds were detected in these samples.

4.1.3 Past Landfills (Site Nos. 5-8)

The initial field investigation program at Site Nos. 5-8 included the installation of two upgradient monitoring wells, the sampling of these two new wells and four existing wells, and the collection of surface water and sediment samples from five locations.

Two monitoring wells were installed along the north side of South-shore Road upgradient of the old landfill areas. Well MD58-5 was drilled to a depth of 22 feet, and well MD58-6 was drilled to a depth of 10 feet. Both wells were completed in the sandy materials of the surficial aquifer. Visual examination of samples and cuttings, and monitoring with the HNU organic vapor detector during drilling, did not reveal the presence of any contaminants.

Groundwater levels were measured in October 1986, January 1987 and again in August 1987. Water level elevations are given below (in feet, MSL) for all wells at Site Nos. 5-8.

October 1986		January 1987		August 1987	
		High Tide	Low Tide	High Tide	Low Tide
MD58-1	1.34	1.75	0.99	1.56	0.86
MD58-2	1.59	1.45	0.88	--	0.66
MD58-3	1.94	2.08	2.01	1.75	1.68
MD58-4	1.95	2.32	2.28	1.98	1.90
MD58-5	1.88	4.23	3.93	2.80	2.67
MD58-6	4.58	5.23	5.14	4.25	4.17

TABLE 4.3
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR
SEDIMENT SAMPLES FROM SITE NO. 3
OCTOBER 1986

Sample Identifier	Volatile Organics (SW 5030/8240) (mg/kg dry weight)	Semivolatile Organics (SW 3550/8270) (mg/kg dry weight)	Metals (SW 1310/6010, SW 7471) ^b (mg/L)
DK MD3-SD1 ES	ND	ND	ND ^a
DK MD3-SD2 ES	ND	ND	ND
DK MD3-SD3 ES	ND	ND	Arsenic - 0.01
DK MD3-SD4 ES	ND	ND	Selenium - 0.01
DK MD3-SD5 ES	ND	ND	ND
DK MD3-SD6 ES	ND	ND	Arsenic - 0.03 Selenium - 0.02
DK MD3-SD7 ES	ND	ND	ND

ND - Not detected.

a - Average of analyses of a field sample and an internal duplicate (QC) sample.

b - To meet the target detection limits, three metals were analyzed by graphite furnace AAS instead of ICPE: As (SW7060), Se (SW7740), Pb (SW7421).

Based on the above water level measurements, general groundwater flow at this site is south towards the mangrove swamps and Tampa Bay (Figure 4.4). Groundwater flow directions and gradients are influenced by tidal changes. Extremely high or low tides will cause even greater disruptions to this system.

Groundwater and surface water samples from the first investigation were analyzed for purgeable halocarbons, purgeable aromatics, base/neutral and acid extractable organics, and metals. The results of these analyses are given in Table 4.4 along with the results of field analyses. Water from well MD58-4 showed the presence of purgeable halocarbons and purgeable aromatics that were confirmed by second-column GC analyses. These were: chlorobenzene at 4.4 to 5.3 ug/L, 1,4-dichlorobenzene at 2.2 to 12 ug/L, benzene at 33 to 45 ug/L, and 1,1-dichloroethane at 1.4 ug/L. Base/neutral and acid extractable organics were reported for all samples except those from surface water stations SW-1 and SW-3 (see Figure 3.5). Bis(2-ethylhexyl)phthalate was reported in levels ranging from 100 ug/L to 500 ug/L in groundwater samples, and at 23 ug/L in two surface water samples. Di-n-butylphthalate was reported in both groundwater and surface water samples in levels ranging from 4 ug/L to 41 ug/L. The metals scans revealed the presence of various metals in the water samples (see Table 4.4). Field analyses showed pH in groundwater ranging from 5.5 to 6.7 and in surface water ranging from 6.9 to 8.0. Conductivities of groundwater samples ranged from 200 umhos/cm to 8200 umhos/cm, and conductivities of all surface water samples were above 20,000 umhos/cm. High conductivity readings, plus high sodium and magnesium levels in the surface water and two groundwater samples (MD58-1, MD58-2), indicate that this site is affected by the brackish water in the tidal creeks draining the site.

Sediment samples from Site Nos. 5-8 were analyzed for volatile organics, semivolatile organics, and EP toxicity metals. The results of analyses on sediments from Site Nos. 5-8 are given in Table 4.5. No compounds were found in these samples above the detection limits.

The second field investigation at Site Nos. 5-8 was conducted in August 1987 and consisted of the collection and analysis of a second round of samples from the surface water stations and the groundwater

MACDILL AFB GROUNDWATER CONTOUR MAP AND FLOW DIRECTION FOR SITE 5-8

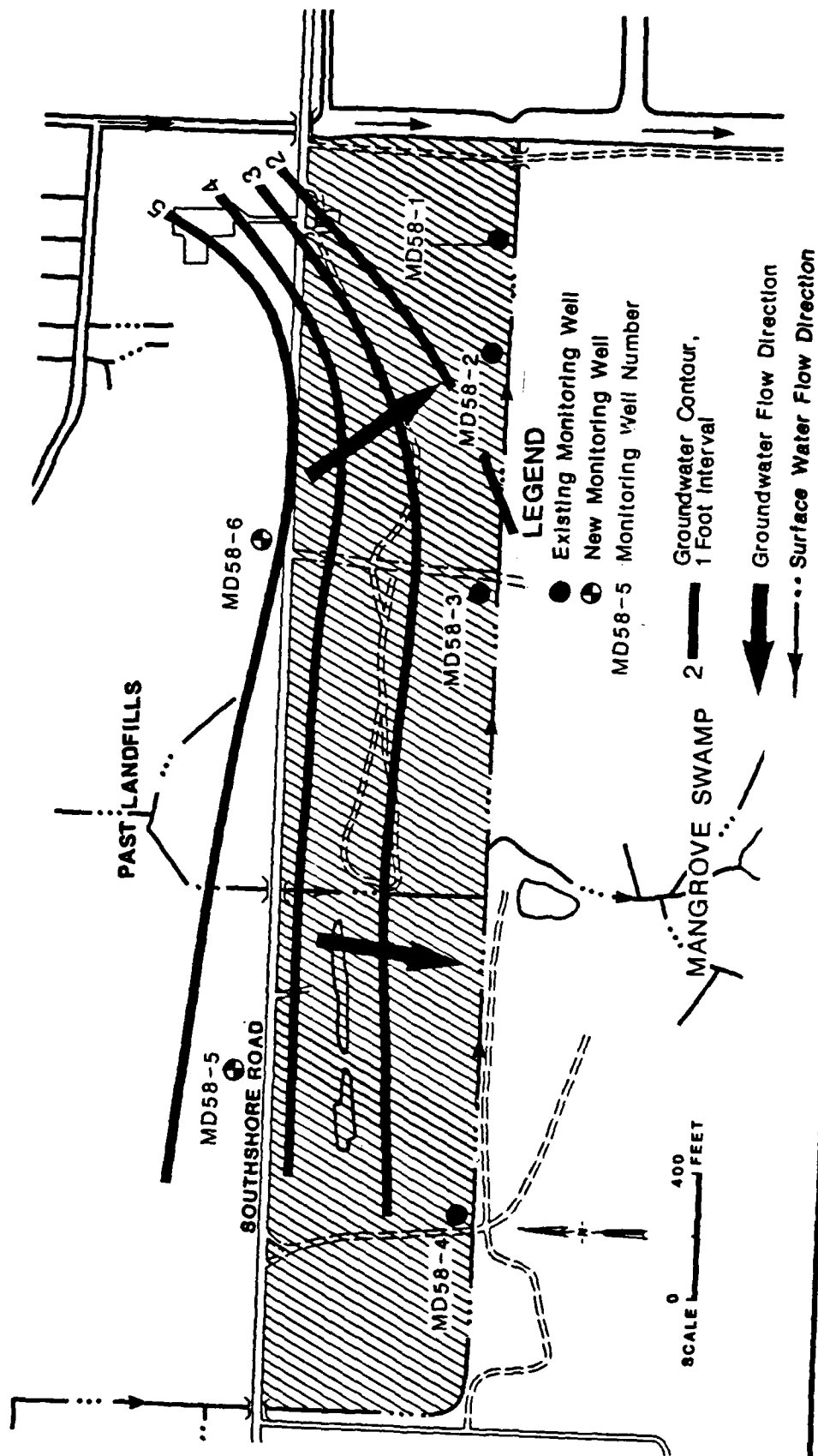


FIGURE 4.4

TABLE 4.4
SUMMARY OF CHEMICAL ANALYSES RESULTS FOR GROUNDWATER AND SURFACE WATER SAMPLES
FROM SITE NO. 5-8

PART A: LABORATORY RESULTS

Sample Identifier	Purgeable Halocarbons (E601) (ug/L)	Purgeable Aromatics (E602) (ug/L)	Base/Neutral and Acid Extractable Organics (E625) (ug/L)	Metals Scan ^{c,f} (E200.7/245.1) (ug/L)
<u>First Round Samples, October 1986</u>				
PL MD58-1 GW ES	ND ^e	ND ^c	Bis(2-ethylhexyl) phthalate-100 Di-n-butyl phthalate-17	Aluminum-1.9 Arsenic-0.01 Boron-1.5 Calcium-340 Iron-0.60 Silica-15 Lead-0.13 ^b Magnesium-310 Manganese-0.08 Potassium-110 Selenium-0.17 ^b Sodium-1900
PL MD58-2 GW ES	ND	ND	Bis(2-ethylhexyl) phthalate-210 Di-n-butyl phthalate-24	Aluminum-2.1 Boron-0.38 Calcium-75 Iron-1.6 Lead-0.024 Magnesium-110 Potassium-34 Selenium-0.05b Silica-14 Sodium-1000
PL MD58-3 GW ES	ND	ND	Bis(2-ethylhexyl) phthalate-270 Di-n-butyl phthalate-15	Aluminum-6.3 Boron-0.20 Calcium-55 Iron-1.3 Magnesium-29 Potassium-13 Silica-23 Sodium-290 Vanadium-0.08
PL MD58-4 GW ES	Chlorobenzene-4.4 1,4-Dichlorobenzene-2.1 1,1-Dichloroethane-1.3	Benzene-31 ^a Chlorobenzene-5.1 ^a 1,4-Dichlorobenzene-11	Bis(2-ethylhexyl) phthalate-200 Di-n-butyl phthalate-18	Iron-14 ^e Magnesium-27 ^e Potassium-38 ^e Silica-18 ^e Sodium-65
PL MD58-5 GW ES	ND ^e	ND ^{b,c}	Bis(2-ethylhexyl) phthalate-500 Di-n-butyl phthalate-41	Potassium-37 Silica-29 Sodium-31 Vanadium-0.08
PL MD58-6 GW ES	ND	ND	Bis(2-ethylhexyl) phthalate-140 Di-n-butyl phthalate-14	Aluminum-3.0/3.0 ^e Barium-0.08 ^e Boron-1.1 ^e Calcium-100 ^e
PL MD58-7 GW ES (Duplicate of MD58-4)	1,4-Dichlorobenzene - 2.3 1,1-Dichloroethane - 1.4	Benzene - 45 1,4-Dichlorobenzene - 12	Bis(2-ethylhexyl) phthalate - 170 Di-n-butyl phthalate - 16	Aluminum-7.6 Calcium-150 Iron-5.5 Magnesium-9.5
				Aluminum-33 Arsenic-0.03 Calcium-48 Iron-3.6 Lead-0.01
				Potassium-3.0 Potassium-2.3 Silica-50 Sodium-12
				Potassium-38 Silica-18 Sodium-63 Magnesium-26

TABLE 4.4 (Cont.)
SUMMARY OF CHEMICAL ANALYSES RESULTS FOR GROUNDWATER AND SURFACE WATER SAMPLES
FROM SITE NO. 5-8

PART A: LABORATORY RESULTS (Continued)

Sample Identifier	Purgeable Halocarbons (E601) (ug/L)	Purgeable Aromatics (E602) (ug/L)	Acid Extractable Organics (E625) (ug/L)	Base/Neutral and Acid Extractable Organics (E625) (ug/L)	Metals Scan ^{c,f} (E200.7/245.1) (mg/L)
PL MD58-SW1 ES	ND	ND	ND	Aluminum-0.17 Arsenic-0.01 Boron-1.8 Calcium-260 Iron-0.30 Lead-0.03 ^b	Magnesium-720 Potassium-180 Selenium-0.08 ^b Silica-3.5 Sodium-4300
PL MD58-SW2 ES	ND	ND	Bis(2-ethylhexyl) phthalate-23 Di-n-butyl phthalate-5	Aluminum-0.23 Boron-1.7 Calcium-240 Iron-0.34 ^b Lead-0.02 ^b	Magnesium-650 Potassium-180 ^b Selenium-0.08 ^b Silica-4.5 Sodium-4700
PL MD58-SW3 ES	ND	ND	ND	Aluminum-0.25 Arsenic-0.01 Boron-1.7 Calcium-220 Iron-0.31 ^b Lead-0.02 ^b	Magnesium-600 Potassium-170 ^b Selenium-0.38 ^b Silica-1.3 Sodium-4600
PL MD58-SW4 ES	ND	ND	Bis(2-ethylhexyl) phthalate-23 Di-n-butyl phthalate-5	Arsenic-0.01 Boron-1.8 Calcium-290 Iron-0.44 ^b Lead-0.02 ^b	Magnesium-640 Manganese-0.06 Potassium-160 ^b Selenium-0.07 ^b Silica-0.45 Sodium-4400
PL MD58-SW5 ES	ND	ND	Di-n-butyl phthalate-4	Arsenic-0.01 Boron-1.5 Calcium-0.01 Iron-0.60 ^b Lead-0.02 ^b	Magnesium-460 Potassium-150 ^b Selenium-0.07 ^b Silica-3.2 Sodium-4200

TABLE 4.4 (Cont.)
SUMMARY OF CHEMICAL ANALYSES RESULTS FOR GROUNDWATER AND SURFACE WATER SAMPLES
FROM SITE NO. 5-8

PART A: LABORATORY RESULTS (Continued)

Sample Identifier	Purgeable Halocarbons (E601) (ug/L)	Purgeable Aromatics (E602) (ug/L)	Acid Extractable Organics (E625) (ug/L)	Base/Neutral and Extractable Organics (E625) (ug/L)	Metals Scan C.f (E200.7/245.1) (mg/L)
<u>Second Round Samples, August 1987</u>					
MD58-1 GW ES	Chloromethane - 1.7	ND	ND	ND	--
MD58-2 GW ES	ND	ND	ND	ND	--
MD58-3 GW ES	Chloromethane - 4.5	ND	ND	ND	--
MD58-4 GW ES	Carbon tetrachloride - 9.4 1,4-Dichlorobenzene - 16 1,1-Dichloroethane - 1.7	Benzene - 11 Chlorobenzene - 9.4 1,4-Dichlorobenzene - 16	ND	ND	--
MD58-5 GW ES	ND	ND	ND	ND	--
MD58-6 GW ES	ND	ND	ND	ND	--
MD58-7 GW ES	ND	ND	ND	ND	--
MD58-SW1	1,1-Dichloroethane - 2.1	ND	ND	ND	--
MD58-SW2	ND	ND	ND	ND	--
MD58-SW3	ND	ND	ND	ND	--
MD58-SW4	Chloromethane - 10	ND	ND	ND	--
MD58-SW5	Chloromethane - 9.7	ND	ND	ND	--
MD58-SW6	ND	ND	ND	ND	--

ND - Not detected.

a - Chromatograph contained many hydrocarbon peaks which made identification difficult.

b - The high salinity content of the sample was suspected of causing a positive interference during analysis of the metals indicated.

c - Metals scan included metals and detection limits listed in Table I.2.

d - Average of analyses of a field sample and an internal duplicate (QC) sample.

e - To meet the target detection limits, five metals were analyzed by graphite furnace AAS instead of ICPEES: As(E206.2), Sb(E204.2), Se(E270.2), Pb(E239.2), Mo(E246.2).

TABLE 4.4 (Cont.)
SUMMARY OF CHEMICAL ANALYSES RESULTS FOR GROUNDWATER AND SURFACE WATER SAMPLES
FROM SITE NO. 5-8

PART B: FIELD MEASUREMENTS

Site No. 5-8	pH	Conductivity (umhos/cm)	Temperature (°C)
October 1986			
PL MD58-1 GW ES	6.1	8,100	29
PL MD58-2 GW ES	5.5	8,200	28
PL MD58-3 GW ES	6.6	900	29
PL MD58-4 GW ES	6.7	840	29
PL MD58-5 GW ES	6.4	400	27
PL MD58-6 GW ES	5.7	200	28
PL MD58-SW1 ES	7.3	>20,000	23
PL MD58-SW2 ES	6.9	>20,000	23
PL MD58-SW3 ES	7.5	>20,000	27
PL MD58-SW4 ES	8.0	>20,000	27
PL MD58-SW5 ES	7.7	>20,000	28
August 1987			
MD58-1 GW ES	6.0	2,500	27
MD58-2 GW ES	-	13,200	26
MD58-3 GW ES	-	1,000	27
MD58-4 GW ES	-	1,500	28
MD58-5 GW ES	-	350	28
MD58-6 GW ES	-	350	29
MD58-SW1	6.5	>20,000	27
MD58-SW2	-	>20,000	28
MD58-SW3	-	>20,000	28
MD58-SW4	-	18,250	29
MD58-SW5	-	16,000	28

TABLE 4.5
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR
SEDIMENT SAMPLES FROM SITE NO. 5-8
OCTOBER 1986

Sample Identifier	Volatile Organics (SW 5030/8240) (mg/kg dry weight)	Semivolatile Organics (SW 3550/8270) (mg/kg dry weight)	Metals (SW 1310/6010, SW 7471) ^a (mg/L)
PL MD58-SD1 ES	ND	ND	ND
PL MD58-SD2 ES	ND	ND	ND
PL MD58-SD3 ES	ND	ND	ND
PL MD58-SD4 ES	ND	ND	ND
PL MD58-SD5 ES	ND	ND	ND

ND - Not detected.

a - To meet the target detection limits, three metals were analyzed by graphite furnace AAS instead of ICPE: As(SW7060), Se(SW7740), Pb(SW7421).

monitoring wells. These samples were analyzed for purgeable halocarbons, purgeable aromatics, and base/neutral and acid extractable organics. Again, water from well MD58-4 showed the presence of purgeable halocarbons and purgeable aromatic organics: carbon tetrachloride at 9.4 ug/L, 1,4-dichlorobenzene at 16 ug/L, 1,1-dichloroethane at 1.7 ug/L, benzene at 11 ug/L and chlorobenzene at 9.4 ug/L. In addition, chloromethane was reported at 1.7 ug/L in well MD58-1 and 4.5 ug/L in well MD58-3. No other purgeable halocarbons or purgeable aromatic organics were found in water samples from the other monitoring wells and no base/neutral and acid extractable organics were found in the groundwater samples or surface water samples. The sample from surface water station MD58-SW1 showed 1,1-dichloroethane at 2.1 ug/L. Chloromethane was reported for surface water sampling stations MD58-SW4 and MD58-SW5 at concentrations of 10 and 9.7 ug/L respectively. No other purgeable halocarbons or purgeable aromatic organics were detected in any surface water station samples.

4.1.4 Recent Landfill (Site No. 9)

The initial field investigation at Site No. 9 included an ER survey, the installation of four monitoring wells, and the collection and analysis of six groundwater samples and two surface water and sediment samples. The ER survey consisted of one sounding and several profiles around the landfilled area. The ER sounding was inconclusive in distinguishing between the various subsurface materials. The ER profiles showed areas of low resistivity near the creek boundaries and the tidal pond. These values are interpreted as being high conductivities associated with the brackish surface waters.

Four monitoring wells were installed at Site No. 9, ranging in depth from 9 feet to 14 feet. The borings encountered sandy materials overlying clayey materials. All wells were completed in the sandy materials of the surficial aquifer. Visual examination of samples and cuttings, and monitoring with the HNU organic vapor detector during drilling did not reveal the presence of any contaminants.

Groundwater levels were measured in existing wells MD9-2 and MD9-3 plus the four new wells in October 1986, in January 1987 and again in August 1987. Monitoring well MD9-1, installed during the Phase II, Stage 1 effort, could not be found and was presumed destroyed. Water level elevations are given below (in feet, MSI).

<u>October 1986</u>		<u>January 1987</u>		<u>August 1987</u>	
		<u>High Tide</u>	<u>Low Tide</u>	<u>High Tide</u>	<u>Low Tide</u>
MD9-2	3.14	2.52	1.59	2.41	1.15
MD9-3	0.75	--	1.95	--	1.77
MD9-4	4.06	5.17	4.94	3.21	3.24
MD9-5	5.11	5.66	5.95	4.29	4.30
MD9-6	5.43	5.97	5.85	4.45	4.43
MD9-7	4.67	5.17	5.02	3.19	3.13

The general groundwater flow direction, based upon these measurements, is towards the tidal drainage ditch north of Rattlesnake Road and towards Broad Creek and the Mangrove Swamps (Figure 4.5). A groundwater mounding is evident in the landfill.

Groundwater and surface water samples collected during the initial investigation at Site No. 9 were analyzed for purgeable halocarbons, purgeable aromatics, base/neutral and acid extractable organics, and metals. Table 4.6 gives a summary of all analyses of water samples at Site No. 9 plus the results of field analyses. In Well MD9-3 benzene was found and confirmed at 2.4 ug/L and surface water sample MD9-SW2 showed di-n-butyl phthalate at 3 ug/L. No other organic contaminants were found in water samples collected during this investigation at Site No. 9. The metals scan showed the presence of various metals in all water samples. Conductivities ranged from 2200 umhos/cm to >20,000 umhos/cm, indicating that surface waters and groundwater at Site No. 9 are influenced by the brackish water of the tidal streams.

Sediment samples were collected from two locations in the drainage canal on the west side of Site No. 9 (Figure 4.5). These samples were analyzed for volatile organics, semivolatile organics, and EP toxicity metals. Selenium EP toxicity was reported at 0.01 mg/L at location SD-1. A summary of chemical analysis results for sediments at Site No. 9 is given in Table 4.7. No other compounds were found in the sediment samples.

The second field investigation conducted at Site No. 9 in August 1987 consisted of the collection and analysis of samples from four surface water stations and six groundwater monitoring wells. These samples were analyzed for purgeable halocarbons, purgeable aromatics and base/neutral and acid extractable organics. The only samples with detectable compounds were groundwater from MD9-3 with benzene at 4.7 ug/L, groundwater from MD9-5 with methylene chloride at 4.8 ug/L, and

FIGURE 4.5

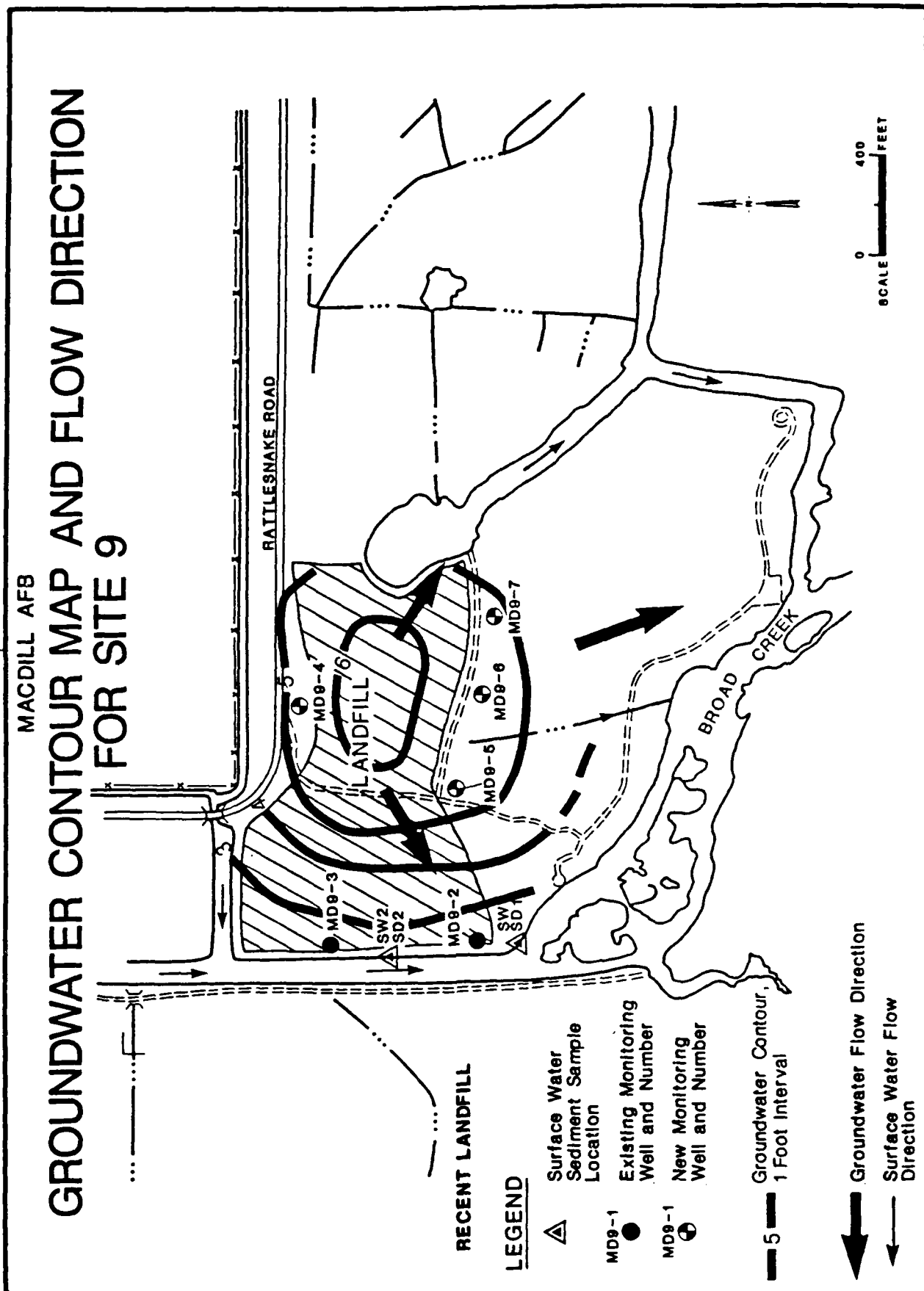


TABLE 4.6
SUMMARY OF CHEMICAL ANALYSIS RESULTS
FOR GROUNDWATER AND SURFACE WATER SAMPLES FROM SITE NO. 9

PART A: LABORATORY RESULTS

Sample Identifier	Purgeable Halocarbons (E601) (ug/L)		Purgeable Aromatics (E602) (ug/L)	Base/Neutral and Acid Extractable Organics (E625) (ug/L)	Metals Scan (E200.7/245.1) ^{b,e} (mg/L)
	MD9-2	MD9-3	MD9-4		
First Round Samples, October 1986					
RL MD9-2 GW ES	ND	ND	ND	ND	Aluminum - 1.7 Boron - 1.5 Calcium - 210 Iron - 0.28 ^a Lead - 0.04 ^a Magnesium - 260 Potassium - 110 Selenium - 0.06 ^a Silica - 42 Sodium - 2400
RL MD9-3 GW ES	ND	Benzene - 2.4	ND	ND	Aluminum - 19 Arsenic - 0.02 ^a Boron - 1.3 Calcium - 150 Iron - 4.5 Lead - 0.01 Magnesium - 160 Manganese - 0.06 Potassium - 110 Selenium - 0.18 ^a Silica - 34 Sodium - 2400 Vanadium - 0.08
RL MD9-4 GW ES	ND ^d	ND ^d	ND ^d	ND	Aluminum - 43 ^a Arsenic - 0.03 ^a Barium - 0.13 Boron - 0.40 Calcium - 180 Chromium - 0.11 Iron - 35 Magnesium - 89 Potassium - 30 Selenium - 0.07 ^a Silica - 110 Sodium - 1000 Vanadium - 0.09 Lead - 0.03 ^a
RL MD9-5 GW ES	ND	ND	ND	ND	Aluminum - 7.9 Arsenic - 0.01 Boron - 0.48 Calcium - 310 Iron - 5.8 Lead - 0.01 Magnesium - 74 Manganese - 0.13 Potassium - 28 Selenium - 0.03 ^a Silica - 31 Sodium - 460 Vanadium - 0.08
RL MD9-6 GW ES	ND	ND	ND	ND	Boron - 0.10 Calcium - 510 Lead - 0.02 ^a Magnesium - 84 Potassium - 9.0 Selenium - 0.09 ^a Silica - 47 Sodium - 890
RL MD9-7 GW ES	ND	ND	ND	ND	Aluminum - 1.9 Boron - 0.55 Calcium - 130 Iron - 16 Lead - 0.02 Magnesium - 73 Potassium - 15 Selenium - 0.07 ^a Silica - 28 Sodium - 890

TABLE 4.6 (cont.)
SUMMARY OF CHEMICAL ANALYSIS RESULTS
FOR GROUNDWATER AND SURFACE WATER SAMPLES FROM SITE NO. 9

PART A: LABORATORY RESULTS (continued)

Sample Identifier	Purgeable Halocarbons (E601) (ug/L)	Purgeable Aromatics (E602) (ug/L)	Base/Neutral and Acid Extractable Organics (E625) (ug/L)	Metals Scan (E200.7/245.1) ^{b,e} (mg/L)
RL MD9-8 GW (Duplicate of MD9-3)	ND	ND	ND	Aluminum - 18 Arsenic - 0.02 Boron - 1.3 Calcium - 150 Iron - 4.8 Lead - 0.01 Magnesium - 170 Manganese - 0.06 Potassium - 110 Selenium - 0.20 Silica - 35 Sodium - 2500 Vanadium - 0.09
RL MD9-SW1 ES	ND ^d	ND ^d	ND	Arsenic - 0.02 ^a Boron - 1.8 Calcium - 270 Iron - 0.12 Lead - 0.05 ^a Magnesium - 510 Potassium - 240 Selenium - 0.47 ^a Silica - 2.2 Sodium - 6600
RL MD9-SW2 ES	ND	ND	Di-n-butyl phthalate-3	Aluminum - 0.21 Arsenic - 0.02 Boron - 2.4 Calcium - 260 Iron - 0.19 ^a Lead - 0.05 ^a Magnesium - 850 Potassium - 240 Selenium - 0.45 ^a Silica - 2.7 Sodium - 6700
Second Round Samples, August 1987				
MD9-2 GW ES	ND	ND	ND	--
MD9-3 GW ES	ND	Benzene - 4.7	ND	--
MD9-4 GW ES	ND	ND	ND	--
MD9-5 GW ES	Methylene Chloride - 4.8	ND	ND	--
MD9-6 GW ES	ND	ND	ND	--
MD9-7 GW ES	ND	ND	ND	--
MD9-SW1 ES	ND	ND	ND	--
MD9-SW2 ES	Chloroform - 0.47	ND	ND	--
MD9-SW3 ES	ND	ND	ND	--
MD9-SW4 ES	ND	ND	ND	--

ND - Not detected.

a - The salinity content of the sample was suspected of causing a positive interference during analysis of the metals indicated.
b - Metals scan included metals and detection limits listed in Table 1.2.

d - Average of analyses of field sample and an internal duplicate (QC) sample.

e - To meet the target detection limits, five metals were analyzed by graphite furnace AAS instead of ICPEs: As(E206.2), Sb(E204.2), Se(E270.2), Pb(E239.2), Mo(E246.2).

TABLE 4.6 (cont.)
SUMMARY OF CHEMICAL ANALYSIS RESULTS
FOR GROUNDWATER AND SURFACE WATER SAMPLES FROM SITE NO. 9

PART 8: FIELD MEASUREMENTS

October 1986

Site No. 9	pH	Conductivity (umhos/cm)	Temperature (°C)
RL MD9-2 GW ES	6.6	7,800	29
RL MD9-3 GW ES	6.5	9,480	26
RL MD9-4 GW ES	4.9	3,800	28
RL MD9-5 GW ES	6.8	2,200	27
RL MD9-6 GW ES	6.2	4,400	29
RL MD9-7 GW ES	5.7	3,800	28
RL MD9-SW1 ES	-	20,000	-
RL MD9-SW2 ES	-	20,000	-

August 1987

MD9-2 GW ES	-	7,000	27
MD9-3 GW ES	-	7,800	27
MD9-4 GW ES	-	2,000	29
MD9-5 GW ES	5.5	3,500	26
MD9-6 GW ES	5.0	6,500	26
MD9-7 GW ES	5.3	6,000	26
MD9-SW1	-	18,500	30
MD9-SW2	-	19,500	30
MD9-SW3	6.5	>20,000	31
MD9-SW4	6.9	>20,000	31

TABLE 4.7
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR
SEDIMENT SAMPLES FROM SITE NO. 9
OCTOBER 1986

Sample Identifier	Volatile Organics (SW 5030/8240) (mg/kg dry weight)	Semivolatile Organics (SW 3550/8270) (mg/kg dry weight)	Metals (SW 1310/6010, SW 7471) ^a (mg/L)
RL MD9-SD1 ES	ND	ND	Selenium - 0.01
RL MD9-SD2 ES	ND	ND	ND

ND - Not detected.

a - To meet the target detection limits, three metals were analyzed by graphite furnace AAS instead of ICPEs: As (SW 7060), Se (SW 7740), Pb (SW 7421).

surface water MD9-SW2 with chloroform at 0.47 ug/L. No other compounds were detected in the surface water or groundwater samples.

4.1.5 Chemical Munitions Burial Area (Site No. 11)

The initial field investigation program at Site No. 11 included a search for information on the chemical munitions burial area, and the collection and analysis of three surface water and sediment samples. Information gathered on Site No. 11 indicated that a possible chemical munitions burial area was formerly located south of Southshore Road, across from the old SAC Alert Area, near the drainage canal that runs from north to south (Figure 4.6). A visual inspection of the area and examination of old aerial photographs did not confirm any location as the chemical munitions burial area.

Surface water and sediment samples were collected during the initial investigation from three locations in the suspected area (Figure 4.6). The surface water samples were analyzed for purgeable halocarbons, purgeable aromatics, base/ neutral and acid extractable organics, and metals. These results and field analysis results are given in Table 4.8. No organic contaminants were found in the surface water samples. Conductivities of all samples were above 20,000 umhos/cm, which along with high sodium levels (5,800 to 8,400 mg/L), indicated the influence of brackish water in the tidal creek.

The sediment samples were analyzed for volatile organics, semi-volatile organics, and EP toxicity metals (Table 4.9). Bis(2-ethyl-hexyl)phthalate was reported at 0.55 mg/kg in sample SD-1 and di-n-butylphthalate was reported at 0.43 mg/kg in sample SD-2. No other organic compounds or metals were found in these sediment samples.

Additional field work conducted at Site No. 11 during August of 1987 consisted of a geophysical survey in the suspected burial area. A magnetic survey and an electromagnetic survey were conducted in areas that were suspected of being disturbed. These areas were identified by a field reconnaissance and from aerial photographs and maps. Geophysical results were inconclusive in identifying areas of buried metallic wastes.

FIGURE 4.6

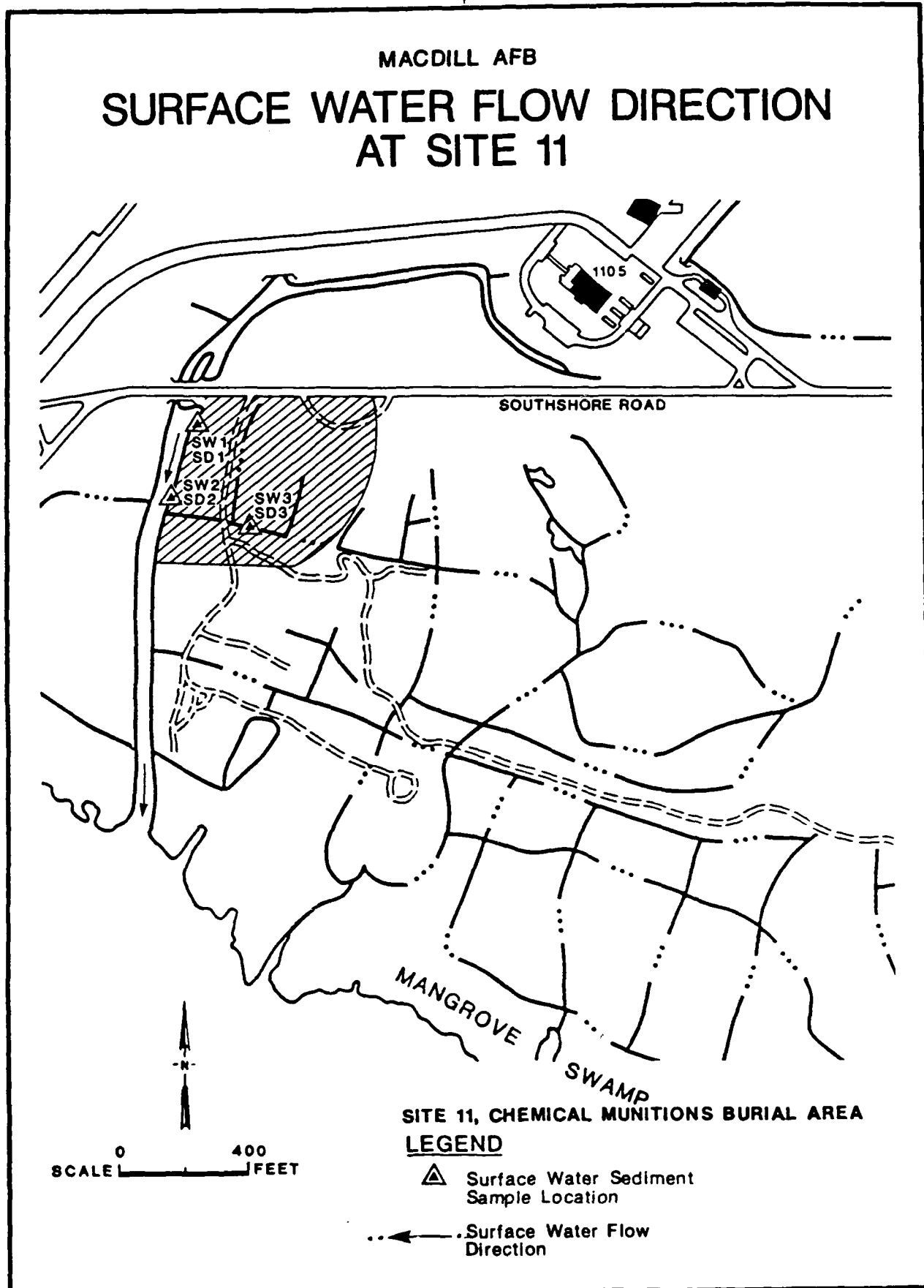


TABLE A.2
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR SURFACE WATER
SAMPLES FROM SITE NO. 11
OCTOBER, 1986

PART A: LABORATORY RESULTS

Sample Identifier	Purgeable Halocarbons (F601) (ug/L)	Purgeable Aromatics (F602) (ug/L)	Base/Neutral and Acid Extractable Organics (F625) (ug/L)	Metal Scan ^{b,d} (F200.7/245.1) (mg/L)
CM MD11-SW1 ES	ND ^c	ND ^c	ND	Aluminum - 0.12 Arsenic - 0.01 Boron - 1.9 Calcium - 380 Iron - 0.12 Lead - 0.05 ^a Magnesium - R20 Potassium - 220 Selenium - 0.09 ^a Silica - 3.1 Sodium - 5800
CM MD11-SW2 ES	ND	ND	ND	Aluminum - 0.35 Arsenic - 0.01 Boron - 2.4 Calcium - 430 Iron - 0.35 Lead - 0.06 ^a Magnesium - 990 Potassium - 270 ^a Selenium - 0.09 ^a Silica - 3.0 Sodium - 7300
CM MD11-SW3 ES	ND	ND	ND	Aluminum - 0.59 Arsenic - 0.01 Boron - 2.7 Calcium - 460 Iron - 0.52 Lead - 0.06 ^a Magnesium - 1100 Potassium - 310 Selenium - 0.09 ^a Silica - 3.6 Sodium - 8400 Zinc - 0.06

ND - Not detected.

a - The salinity content of the sample was suspected of causing a positive interference during analysis of the metals indicated.

b - Metals scan included.

c - Average of analyses of a field sample and an internal duplicate (QC) sample.

d - To meet the target detection limits, five metals were analyzed by graphite furnace AAS instead of ICPS: As (F206.2), Sb (F204.2), Se (F220.2), Pb (F239.2), Mo (F246.2).

PART B: FIELD MEASUREMENTS

Site No. 11	pH	Conductivity (umhos/cm)	Temperature (°C)
CM MD11-SW1 ES	7.5	520,000	25
CM MD11-SW2 ES	7.1	520,000	25
CM MD11-SW3 ES	6.3	520,000	24

TABLE 4.9
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR
SEDIMENT SAMPLES FROM SITE NO. 11
OCTOBER 1986

Sample Identifier	Volatile Organics (SW 5030/8240) (mg/kg dry weight)	Semivolatile Organics (SW 3550/8270) (mg/kg dry weight)	Metals (SW 1310/601C, SW 7471) ^b (mg/L)
CM MD11-SD1 ES	ND	His(2-ethylhexyl)phthalate - 0.55	ND ^a
CM MD11-SD2 ES	ND	Di-n-butyl phthalate - 0.43	ND
CM MD11-SD3 ES	ND	ND	ND

ND - Not detected.

a - Average of analyses of field sample and an internal duplicate (QC) sample.

b - To meet the target detection limits, three metals were analyzed by graphite furnace AAS instead of ICPEES: As(SW 7060), Se(SW 7740), Pb(SW 7421).

4.1.6 Creosote Pit (Site No. 13)

The field investigation program at Site No. 13 included an electrical resistivity (ER) survey, the installation of three monitoring wells, and the collection and analysis of three groundwater samples. The ER survey consisted of one sounding and several profiles in the site area. The ER sounding did not distinguish between the various lithologies at Site No. 13. The ER profiles showed areas of low resistivity southeast of the surface water retention pond and along C Street south of the Base Exchange Overflow Parking Lot. Monitoring wells MD13-2 and MD13-3 were located in or near the areas of low resistivity.

Three monitoring wells were installed at Site No. 13 (Figure 4.7). All three wells were approximately 20 feet deep and were completed within the sandy sediments of the surficial aquifer. Visual examination of samples and cuttings, and monitoring with the HNU organic vapor detector during drilling did not reveal the presence of contaminants.

Groundwater levels were measured in the three new wells during October 1986. These measurements and the general groundwater flow direction are shown on Figure 4.7.

Groundwater samples collected from the wells at Site No. 13 were analyzed for base/neutral and acid extractable organics. Table 4.10 is a summary of the analyses of water samples and the results of field analyses at Site No. 13. No organic compounds were found in the groundwater samples. Field analysis results of groundwater sampled show pH ranging from 5.5 to 5.9 and specific conductivity ranging from 149 to 273 umhos/cm. This site is apparently not affected by brackish tidal water.

4.1.7 Fuel Tank Farm (Site No. 16)

The initial field investigation program included the collection and analysis of surface water and sediment samples from six locations within drainage ditches at Site No. 16 (Figure 4.8). The surface water samples were analyzed for purgeable halocarbons, aromatic volatile organics (including xylenes), 1,2-dibromoethane (EDB), petroleum hydrocarbons, and lead. Table 4.11 is a summary of the surface water analytical results including field analyses. Chloroform was found and confirmed at 0.6 ug/L in surface water sample MD16-SW5. No other organic compounds were found in the water samples. Lead was found in all surface water

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GROUNDWATER CONTOUR MAP AND FLOW DIRECTION FOR SITE 13

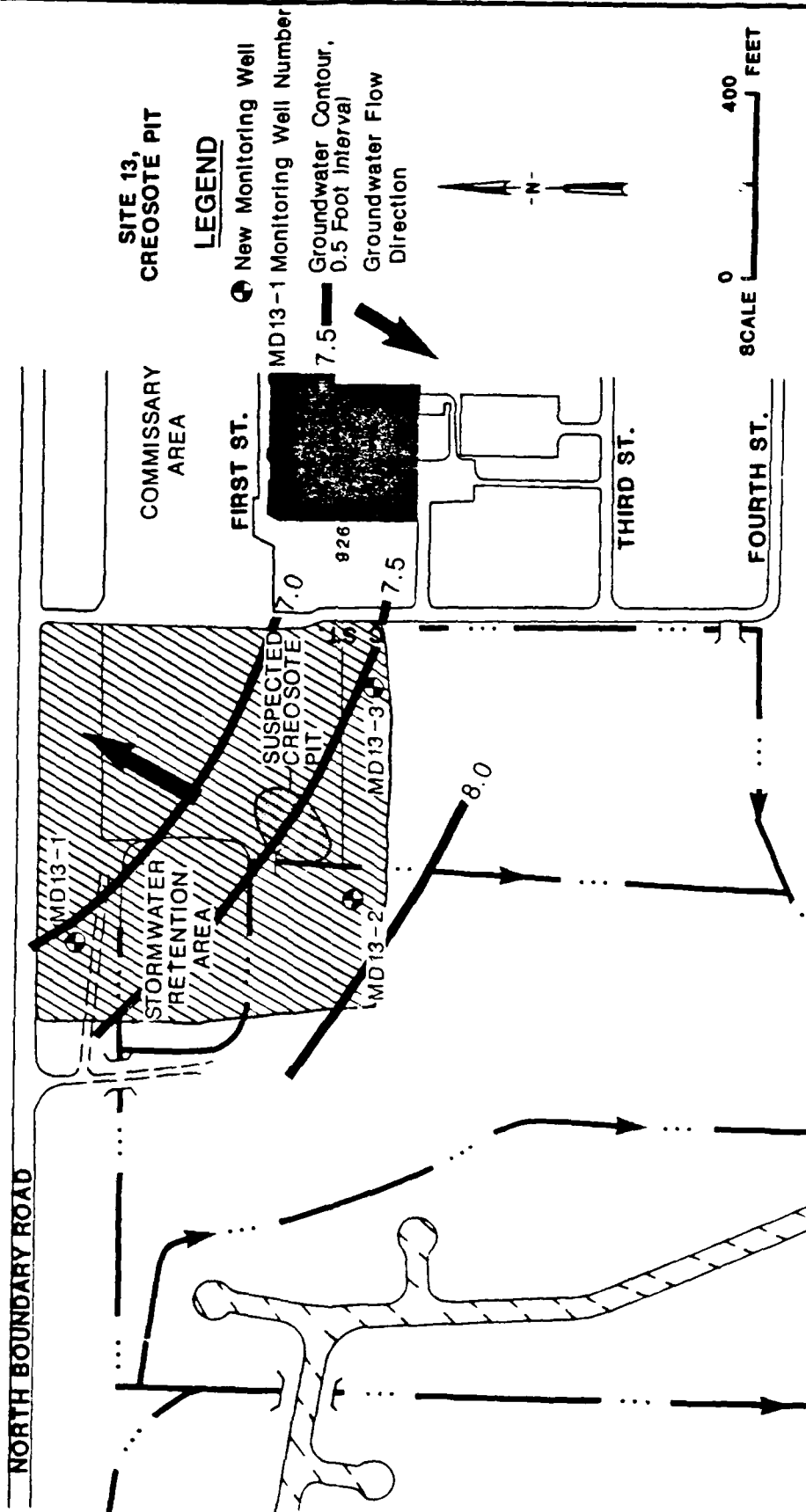


TABLE 4.10
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR
GROUNDWATER SAMPLES FROM SITE NO. 13
OCTOBER 1986

PART A: LABORATORY RESULTS

Sample Identifier	Base/Neutral and Acid Extractable Organics (E625) (ug/L)
CP MD13-1 GW ES	ND
CP MD13-2 GW ES	ND
CP MD13-3 GW ES	ND

ND - Not detected.

PART B: FIELD MEASUREMENTS

Site No. 13	pH	Conductivity (umhos/cm)	Temperature (°C)
CP MD13-1 GW ES	5.9	149	28
CP MD13-2 GW ES	5.5	273	27
CP MD13-3 GW ES	5.7	176	27

FIGURE 4.8

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SURFACE WATER FLOW DIRECTION AT SITE 16

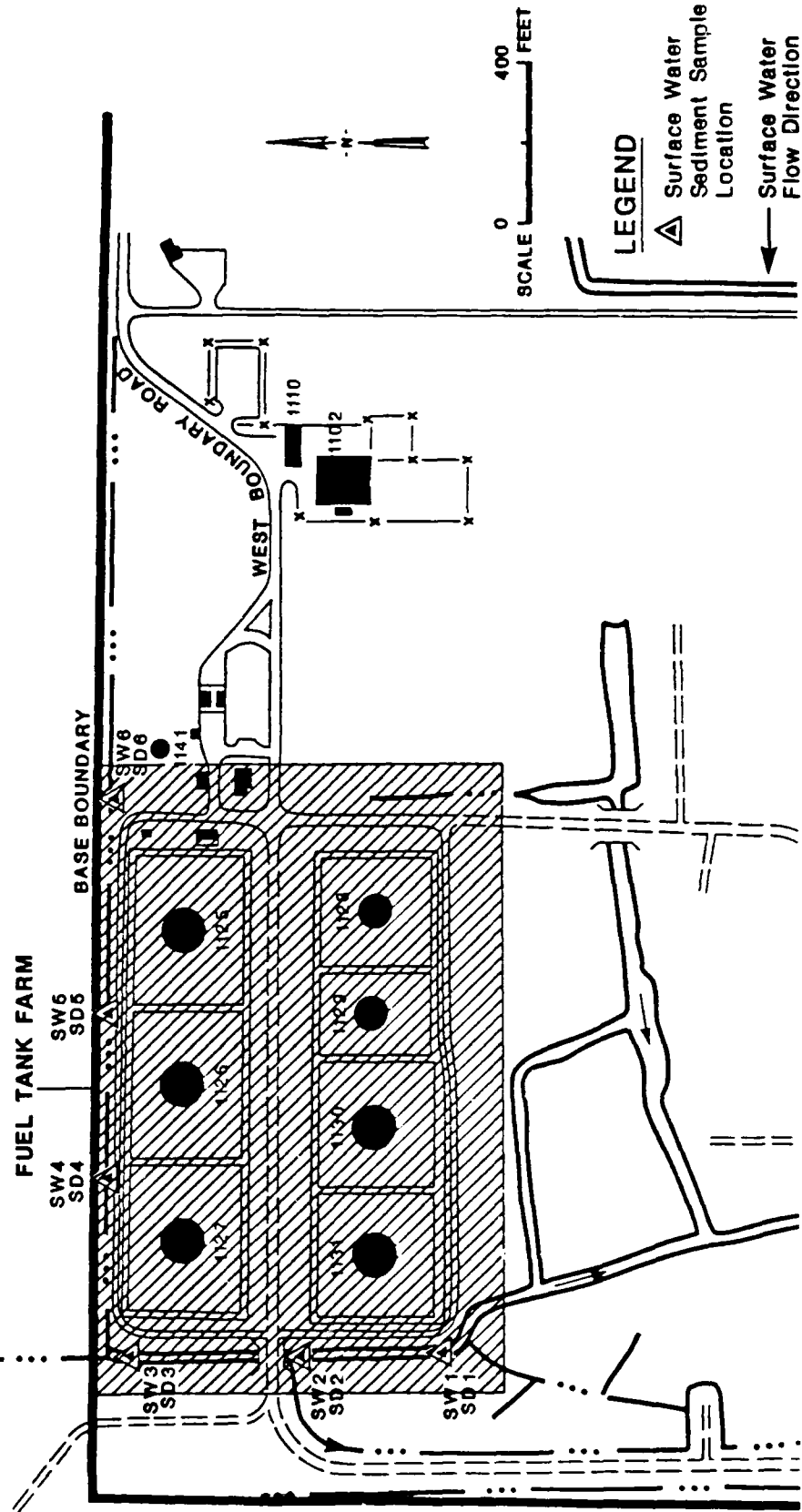


TABLE 4.11
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR SURFACE WATER SAMPLES FROM SITE NO. 16
OCTOBER 1986

PART A: LABORATORY RESULTS

Sample Identifier	Purgeable Halocarbons (E501) (ug/L)	Aromatic Volatile Organics (w/Xylene) (SW 5030/8020) (ug/L)	1,2-Dibromoethane (E501.2) (ug/L)	Petroleum Hydrocarbon (E418.1) (mg/L)	Lead (E239.2) (mg/L)
FT MD16-SW1 ES	ND	ND	ND	ND	0.06 ^b
FT MD16-SW2 ES	ND	ND	ND	ND	0.02 ^b
FT MD16-SW3 ES	ND	ND	ND ^a	ND	0.04 ^b
FT MD16-SW4 ES	ND	ND	ND	ND	0.02 ^b
FT MD16-SW5 ES	Chloroform - 0.6	ND	ND	ND	0.02 ^{a,b}
FT MD16-SW6 ES	ND	ND	ND	ND	0.01 ^b

ND - Not detected.

a - Average of analyses of a field sample and an internal duplicate (QC) sample.

b - The salinity content of the sample was suspected of causing a positive interference during the analysis.

PART B: FIELD MEASUREMENTS

Site No. 16	pH	Conductivity (umhos/cm)	Temperature (C°)
FT MD16-SW1 ES	7.2	>20,000	21
FT MD16-SW2 ES	7.5	18,350	20
FT MD16-SW3 ES	7.4	>20,000	22
FT MD16-SW4 ES	7.2	9,660	21
FT MD16-SW5 ES	7.5	6450	24
FT MD16-SW6 ES	7.6	2790	19

samples, ranging in concentration from 0.01 mg/L to 0.06 mg/L. Field analysis results of samples showed pH ranging from 7.2 to 7.6 and specific conductivity ranging from 2790 umhos/cm to >20,000 umhos/cm. The high conductivity readings indicated the presence of brackish waters due to the tidally influenced drainage canals.

Six sediment samples were collected from locations at Site No. 16 (Figure 4.8) and analyzed for volatile organics, petroleum hydrocarbons, and lead. Table 4.12 summarizes the sediment analysis results. Sediment sample MD16-SD5 showed petroleum hydrocarbons at 2.6 mg/kg. Lead was found in all sediment samples from 10 mg/kg to 100 mg/kg.

4.1.8 Drum Storage Area (Site No. 17)

The initial field investigation program at Site No. 17 included the installation of one monitoring well, and the collection of three groundwater samples, one surface water sample, and three sediment samples.

Monitoring well MD17-3 was installed upgradient at Site No. 17 (Figure 4.9). The well was completed to a depth of 20 feet within the sandy sediments of the surficial aquifer. Visual examination of samples and cuttings, and monitoring with an HNU organic vapor detector, did not reveal the presence of any contamination.

Groundwater levels measured during October 1986 and August 1987 are listed below. Based upon these measurements, ground water flow is to the south.

	<u>October 1986</u>	<u>August 1987</u>
MD17-1	5.86	5.95
MD17-2	5.97	6.13
MD17-3	7.71	7.84
MD17-4	--	5.58

Groundwater and surface water samples from the initial investigation were analyzed for purgeable halocarbons, purgeable aromatics, base/neutral and acid extractable organics, and four metals (lead, cadmium, zinc, and chromium). Table 4.13 summarizes the chemical analysis results of water samples from Site No. 17. Purgeable halocarbons were found and confirmed in groundwater sample MD17-1 in the following concentrations: chloroform was found at 0.4 ug/L, 1,1-dichloroethane

TABLE 4.12
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR
SEDIMENT SAMPLES FROM SITE NO. 16
OCTOBER 1986

Sample Identifier	Volatile Organics (SW 5030/8240) (mg/kg dw)	Petroleum Hydrocarbons (SW 3550/E 418.1) (mg/kg dw)	Lead (SW 3050/7420) (mg/kg dw)
FT MD16-SD1 ES	ND	ND	10
FT MD16-SD2 ES	ND	ND	35
FT MD16-SD3 ES	ND	ND	13 ^a
FT MD16-SD4 ES	ND	ND ^a	11
FT MD16-SD5 ES	ND	2.6	100
FT MD16-SD6 ES	ND	ND	51

ND - Not detected.

a - Average of analyses of a field sample and an internal duplicate (QC) sample.

FIGURE 4.9

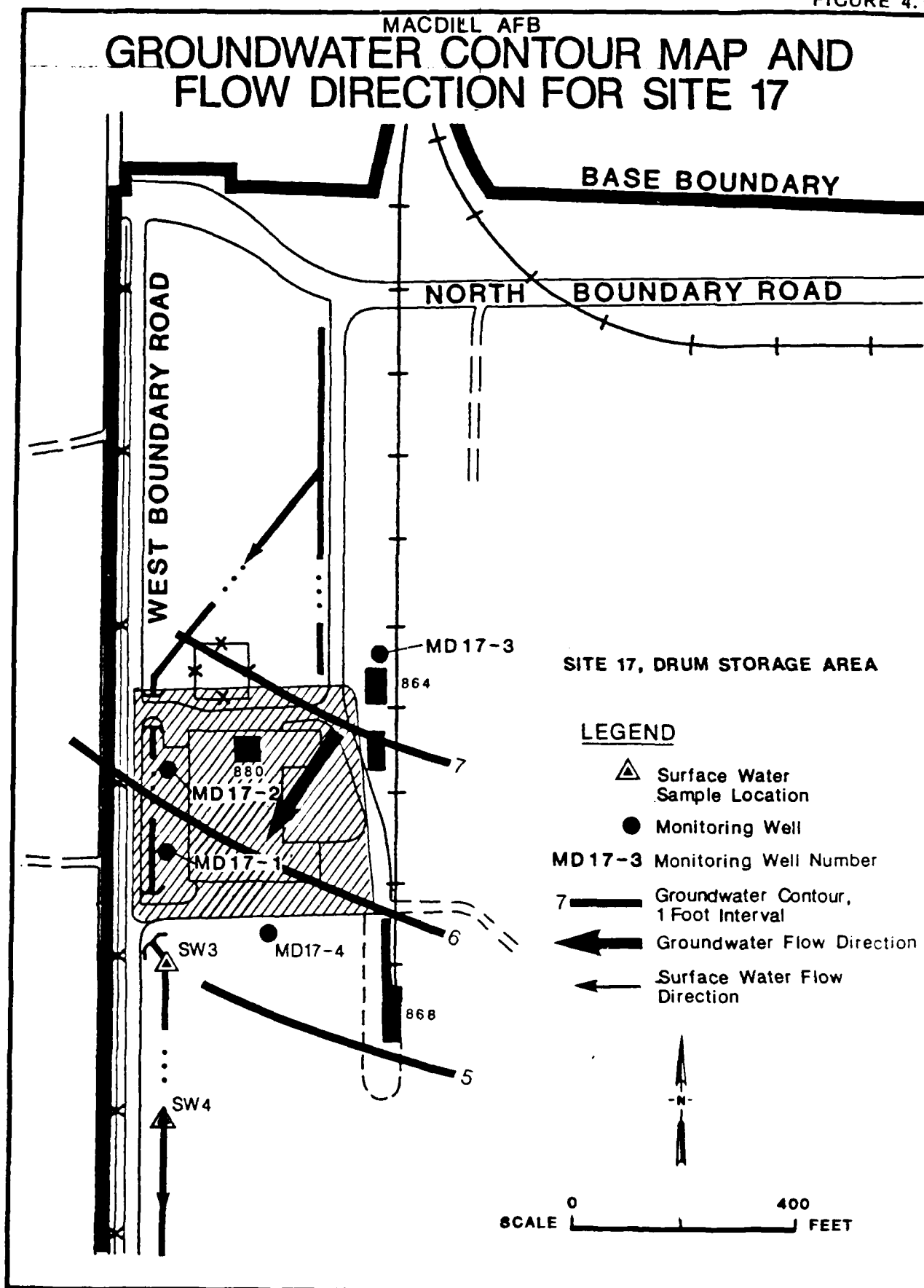


TABLE 4.13
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR GROUNDWATER AND SURFACE WATER SAMPLES
FROM SITE NO. 17

PART A: LABORATORY RESULTS

Sample Identifier	Halocarbons (E601) (ug/L)	Purgeable Aromatics (E602) (ug/L)	Base/Neutral and Acid Extractable Organics (E625) (ug/L)	Metals ^a (mg/L)
<u>First Round Samples, October 1986</u>				
DS MD17-1 GW ES	Chloroform - 0.4 1,1-Dichloroethane - 110 1,2-Dichloroethane - 2.1 1,1-Dichloroethylene - 7.0 1,1,1-Trichloroethane - 8.0	Benzene - 0.9	Bis(2-ethylhexyl) phthalate - 130	^b ND
DS MD17-2 GW ES	ND	ND	Bis(2-ethylhexyl) phthalate - 210 Di-n-butyl phthalate - 25	ND
DS MD17-3 GW ES	ND	ND	ND	ND
DS MD17-SW3 ES	ND	ND	ND	Lead-0.03
<u>Second Round Samples, August 1987</u>				
MD17-1 GW ES	1,1-Dichloroethane - 22 1,2-Dichloroethane - 0.32 1,1-Dichloroethylene - 61 Methylene Chloride - 0.62	ND	ND	--
MD17-2 GW ES	Methylene Chloride - 0.72	ND	ND	--
MD17-3 GW ES	Methylene Chloride - 0.66	ND	ND	--
MD17-4 GW ES	Methylene Chloride - 0.59	ND	ND	--
MD17-5 GW ES (duplicate of MD17-3)	ND	ND	ND	--
MD17-SW3 ES	ND	ND	ND	--
MD17-SW4 ES	Chloroform - 4.6 Methylene Chloride - 1.1	ND	ND	--

ND - Not Detected.

a - E219.2 - Lead
E211.2 - Cadmium
E200.1 - Zinc
E219.2 - Chromium

b - Average of analysis of a field sample and an laboratory duplicate (see) samples.

TABLE 4.13 (Cont.)
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR GROUNDWATER AND SURFACE WATER SAMPLES
FROM SITE NO. 17

PART B: FIELD MEASUREMENTS

	Site No. 17	pH	Conductivity (umhos/cm)	Temperature (C°)
October 1986				
	DS MD17-1 GW ES	5.1	60	29
	DS MD17-2 GW ES	5.0	140	30
	DS MD17-3 GW ES	6.1	280	28
	DS MD17-SW3 ES	6.1	302	21
August 1987				
	MD17-1 GW ES	--	64	27
	MD17-2 GW ES	--	140	27
	MD17-3 GW ES	--	165	27
	MD17-4 GW ES	--	500	27
	MD17-SW3	--	310	28
	MD17-SW4	--	350	29

was found at 110 ug/L, 1,2-dichloroethane was found at 2.3 ug/L, 1,1-dichloroethene was found at 7.0 ug/L, and 1,1,1-trichloroethane was reported at 8.8 ug/L. Benzene was also found and confirmed in groundwater sample MD17-1 at 0.9 ug/L. Other organics were reported in groundwater samples MD17-1 and MD17-2 in the following concentrations: bis(2-ethylhexyl) phthalate was reported at 130 ug/L in sample MD17-1 and at 210 ug/L in sample MD17-2, di-n-butyl phthalate was reported at 25 ug/L in sample MD17-2. Lead was found at 0.03 mg/L in surface water sample MD17-SW3. Field analysis results indicated pH ranging from 5.0 to 6.1 and specific conductivity ranging from 60 umhos/cm and 302 umhos/cm. Based on conductivities, groundwater at this site is not influenced by brackish tidal water.

Three sediment samples were collected at Site No. 17 (Figure 3.10) and analyzed for volatile organics, semivolatile organics, and four metals (lead, cadmium, zinc, and chromium). Table 4.14 gives the results of chemical analyses of sediment samples from Site No. 17. All sediment samples contained various metals at concentrations above the method detection limits. No organic compounds were detected in the sediment samples.

The second field investigation at Site No. 17 included the installation of one additional groundwater monitoring well and the collection and analysis of four groundwater samples and two surface water samples. The new monitoring well, MD17-4, was installed at the southern edge of the site in the surficial aquifer. The well was completed at a depth of 17.5 feet in sandy sediments. Surface water and groundwater samples were analyzed for purgeable halocarbons, purgeable aromatics, and base/neutral and acid extractable organics. One groundwater sample that showed compounds at detectable levels was the groundwater sample from well MD17-1: 1,1-dichloroethane at 22 ug/L, 1,2-dichloroethane at 0.32 ug/L, 1,1-dichloroethylene at 61 ug/L and methylene chloride at 0.62 ug/L. Additionally, Well Nos. MD17-2, 17-3 and 17-4 reportedly had concentrations of methylene chloride of 0.72, 0.66 and 0.59 ug/L respectively. One surface water sample, MD17-SW4, had levels for methylene chloride of 1.1 ug/L and of chloromethane of 4.6 ug/L.

TABLE 4.14
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR
SEDIMENT SAMPLES FROM SITE NO. 17
OCTOBER 1986

Sample Identifier	Volatile Organics (SW 5030/8240) (mg/kg dry weight)	Semivolatile Organics (SW 3550/8270) (mg/kg dry weight)	Metals (SW 3050/7420, 7130, 7950, 7190) (mg/kg dry weight)	
DS MD17-SD1 ES	ND	ND	Lead - 30	Cadmium - ND
			Chromium - 4.3	Zinc - 5.5
DS MD17-SD2 ES	ND	ND	Lead - 25 ^a	Cadmium - 0.33 ^a
			Chromium - 9.7 ^a	Zinc - 30 ^a
DS MD17-SD3 ES	ND	ND	Lead - 23	Cadmium - 0.67
			Chromium - 25	Zinc - 43
DS MD17-SD4 (Duplicate of MD17-SD1)	ND	Pyrene - 0.58 Bis(2-ethylhexyl) phthalate - 0.69	Lead - 46	Cadmium - 0.31
			Chromium - 11	Zinc - 33

ND - Not detected.

a - Average of analyses of a field sample and an internal duplicate (QC) sample.

4.1.9 Fire Training Areas (Site No. 23)

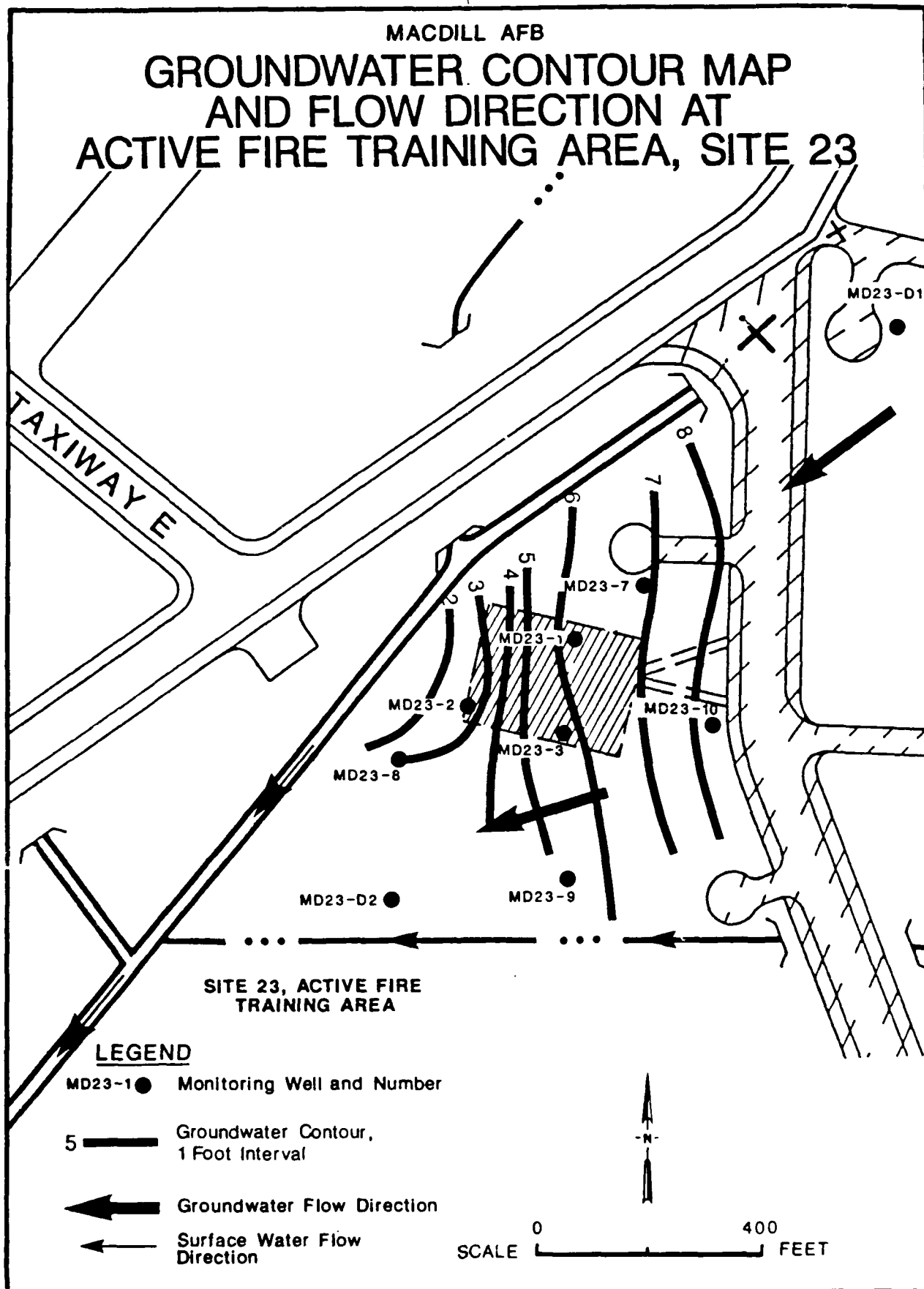
The field investigation program at Site No. 23 included electrical resistivity (ER) surveys at both the Active and Inactive Fire Training Areas, the drilling and installation of three wells into the Upper Floridan Aquifer and eight monitoring wells into the surficial aquifer, an aquifer pumping test in the surficial aquifer including the installation of a shallow observation well, and the collection and analysis of 17 groundwater samples.

The ER survey at the Active Fire Training Area included a sounding and profiles. The sounding, performed east of the active fire pit across the taxiway, did not identify stratigraphic changes although a possible solution cavity or fracture zone was interpreted to exist at approximately 42 feet below ground surface. Profiles at this site show areas of low resistivity to the south and west of the burn pit. Wells MD23-8 and MD23-9 were installed in these areas to confirm or deny the presence of contaminants. Well MD23-10 was installed in an area of low resistivity east of the burn pit for the same purpose.

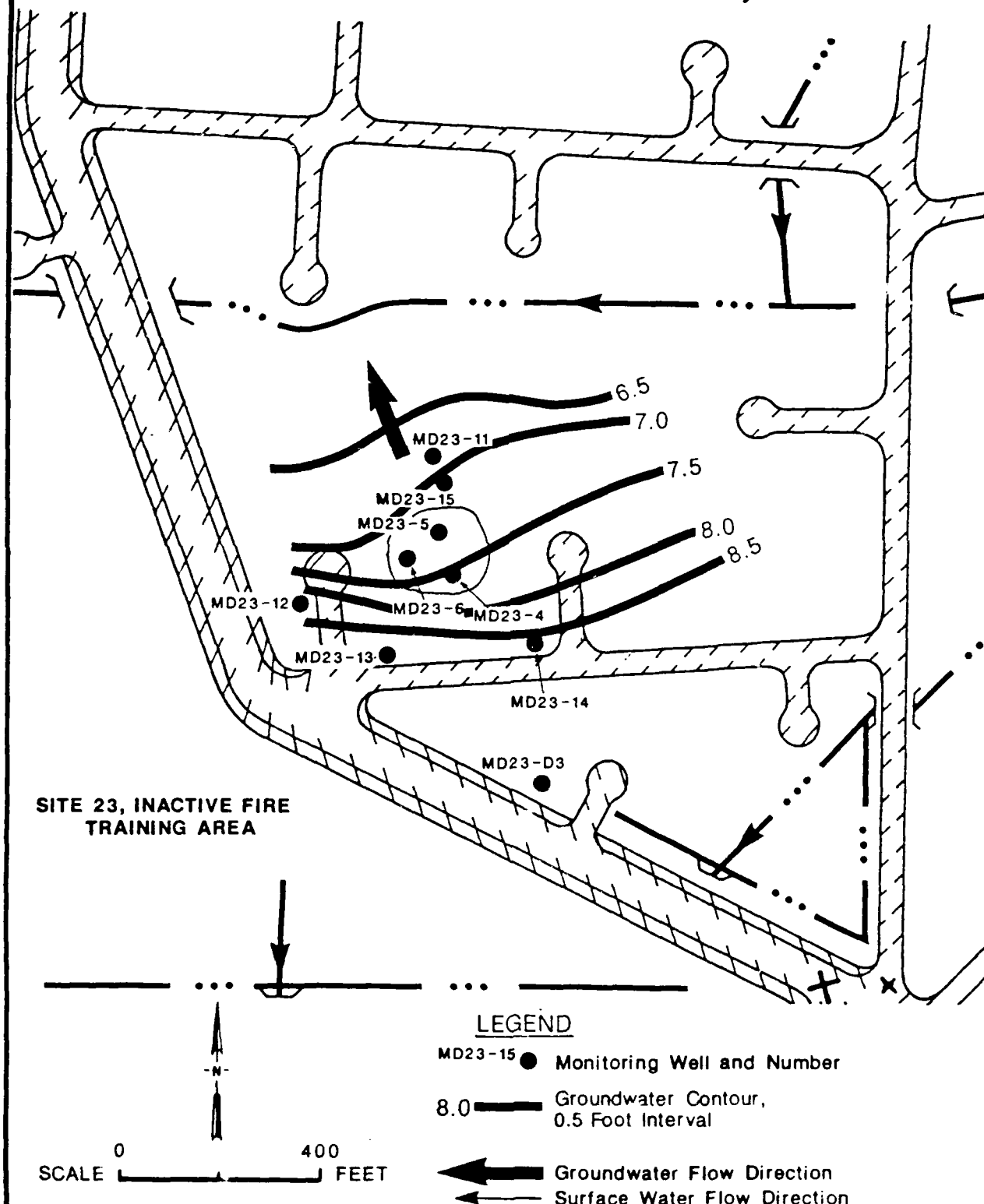
The ER survey at the Inactive Fire Training Area also included a sounding and profiles. This sounding also was not conclusive in distinguishing between stratigraphic layers. The profile data indicated areas of low resistivity to the south and southwest of the burn pit. Wells MD23-12 and MD23-13 were installed in these areas.

Eleven new monitoring wells were installed at Site No. 23. Eight of these wells were completed in the sandy sediments of the surficial aquifer, four around each burn pit. Wells MD23-7, -8, -9, and -10 were installed around the Active Fire Training Area (Figure 4.10). Wells MD23-11, -12, -13, and -14 were installed around the Inactive Fire Training Area (Figure 4.11). These wells range in depth from 14 to 21 feet. Three deeper monitoring wells were completed in the top of the Floridan Aquifer at depths ranging from 57 to 90 feet. Well MD23-D1 is upgradient of Site No. 23 and wells MD23-D2 and MD23-D3 are each downgradient of a burn pit. Boring logs of these deep wells showed sandy sediments from 15 to 30 feet thick overlying clayey materials. The clayey materials are 30 to 50 feet thick and overlie a broken limestone. Visual examination of cuttings and split-spoon samples, and monitoring with the HNU organic vapor detector during drilling did not reveal the presence of any contaminants.

FIGURE 4.10



MACDILL AFB GROUNDWATER CONTOUR MAP AND FLOW DIRECTION AT INACTIVE FIRE TRAINING AREA, SITE 23



Water levels were measured in the monitoring wells during October 1986 and again in January 1987. Water levels seem to vary daily with tidal changes and seasonally with precipitation. Tidal variations were more pronounced in the Floridan Aquifer than in the surficial aquifer. Water table elevations in feet, MSL, are given below.

<u>October 1986</u>		<u>January 1987</u>	
		<u>High Tide</u>	<u>Low Tide</u>
MD23-1	5.03	6.12	6.15
MD23-2	0.89	1.79	1.81
MD23-3	4.72	5.80	5.77
MD23-4	6.14	7.52	7.39
MD23-5	5.94	7.19	7.09
MD23-6	6.07	7.08	6.88
MD23-7	5.42	7.05	6.95
MD23-8	2.35	2.99	3.00
MD23-9	4.13	5.83	5.87
MD23-10	6.93	8.49	8.32
MD23-11	5.33	6.83	6.82
MD23-12	7.21	8.43	8.30
MD23-13	7.52	8.86	8.67
MD23-14	6.99	8.54	8.39
MD23-15	5.55	7.05	6.96
MD23-D1	2.00	2.93	2.51
MD23-D2	1.76	2.91	2.44
MD23-D3	1.85	2.47	2.45

Figures 4.10 and 4.11 show general surficial aquifer groundwater movement directions based on these measurements at Site No. 23.

An aquifer pumping test was performed at the Inactive Fire Training Area using well MD23-11 as the pumping well and MD23-15 as the observation well. The aquifer pumping test results give the average transmissivity of the surficial aquifer as 1805 gallons per day per foot (gpd/ft) and the average hydraulic conductivity as 155 gpd/ft². The storage coefficient was determined to be 0.016. Groundwater flow velocities were calculated using data gathered from the aquifer testing and the results indicate that velocities are on the order of 0.2 to 0.5 feet per day in the surficial aquifer near the Inactive Fire Training Area. Appendix E contains all aquifer pumping test procedures, data, and interpretation.

All groundwater samples collected from wells at Site No. 23 were analyzed for purgeable halocarbons, purgeable aromatics, petroleum hydrocarbons, and lead. Table 4.15 shows the results of analyses for

TABLE 4.15
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR GROUNDWATER SAMPLES FROM SITE NO. 23
OCTOBER 1986

PART A: LABORATORY RESULTS

Sample Identifier	Purgeable Halocarbons (F601) (ug/L)	Purgeable Aromatics (F602) (ug/L)	Petroleum Hydrocarbons (F418.1) (mg/L)	Lead (E239.2) (mg/L)
PA MD23-1 GW ES	ND	Benzene - 640 ^a Ethylbenzene - 150	ND	0.01
PA MD23-2 GW ES	ND	Benzene - 160 Ethylbenzene - 160	0.20	ND
PA MD23-3 GW ES	ND	Benzene - 160 Ethylbenzene - 96	22	ND
PA MD23-4 GW ES	ND	Benzene - 2.7 Toluene - 19	0.50	ND
PA MD23-5 GW ES	ND	Benzene - 32 ^a Toluene - 29	ND	ND
PA MD23-6 GW ES	ND	Benzene - 1.7 Ethylbenzene - 3.6 Toluene - 4.1	ND	ND
FS MD23-7 GW ES	ND	ND	ND	ND
FA MD23-8 GW ES	ND ^b	ND ^b	ND	ND ^b
PA MD23-9 GW ES	ND	ND	ND ^b	ND
PA MD23-10 GW ES	ND ^b	ND ^b	ND	ND
PA MD23-11 GW ES	ND	Toluene - 1.4	ND	ND
PA MD23-12 GW ES	ND ^b	ND ^c	ND	ND
PA MD23-13 GW ES	ND	ND	ND	ND
PA MD23-14 GW ES	ND	ND	ND	ND
PA MD23-16 GW ES (Duplicate of MD23-7)	ND	ND	ND	ND
PA MD23-D1 GW ES	ND	ND	0.20	ND

TABLE 4.15 (cont.)
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR GROUNDWATER SAMPLES FROM SITE NO. 23

PART A: LABORATORY RESULTS (continued)

Sample Identifier	Purgeable Halocarbons (E601) (ug/L)	Purgeable Aromatics (E602) (ug/L)	Petroleum Hydrocarbons (E41R.1) (mg/L)	Lead (E239.2) (mg/L)
FA MD23-D2 GW ES	Chloroform - 0.4	ND	ND	ND
FA MD23-D3 GW ES	ND	ND	0.12	ND

ND - No compound detected above detection limit.

a - Chromatograph contained many hydrocarbon peaks which made identification difficult.

b - Average of analyses of a field sample and an internal duplicate (a) sample.

PART B: FIELD MEASUREMENTS

Site No. 23	pH	Conductivity (umhos/cm)	Temperature (C°)
FA MD23-1 GW ES	6.5	400	26
FA MD23-2 GW ES	6.1	420	27
FA MD23-3 GW ES	6.5	400	28
FA MD23-4 GW ES	7.0	570	28
FA MD23-5 GW ES	6.9	380	28
FA MD23-6 GW ES	6.8	420	28
FA MD23-7 GW ES	6.7	410	29
FA MD23-8 GW ES	5.9	137	25
FA MD23-9 GW ES	6.7	421	25
FA MD23-10 GW ES	6.3	348	26
FA MD23-11 GW ES	6.8	460	25
FA MD23-12 GW ES	5.9	190	28
FA MD23-13 GW ES	7.0	380	28
FA MD23-14 GW ES	7.1	400	27
FA MD23-D1 GW ES	6.9	765	26
FA MD23-D2 GW ES	6.9	867	25
FA MD23-D3 GW ES	7.2	752	25

Site No. 23. Purgeable halocarbons were found and confirmed in two wells: MD23-3 had trans-1,2-dichloroethene at 72 ug/L; and, MD23-D2 had chloroform at 0.4 ug/L. Purgeable aromatics were found and confirmed in all existing wells and in one new well (MD23-11). Benzene ranged from 1.7 to 640 ug/L, ethylbenzene from 3.6 to 310 ug/L, and toluene from 1.4 to 29 ug/L. The higher values were found in wells in the active fire pit. Petroleum hydrocarbons were found in the surficial aquifer at levels ranging from 0.2 to 22 mg/L and in MD23-D1 at 0.20 mg/L, and MD23-D3 at 0.12 mg/L. Lead was found in well MD23-1 at 0.01 mg/L. No other organic or metal contaminants were found in any samples.

Field analyses for groundwater samples at Site No. 23 are shown on Table 4.15. Conductivity values ranged from 137 umhos/cm to 570 umhos/cm in the surficial aquifer samples and from 752 to 867 umhos/cm in the Floridan Aquifer samples. pH values for the surficial aquifer samples ranged from 5.9 to 7.1; the Floridan Aquifer samples showed pH values from 6.9 to 7.2.

4.1.10 Old Landfill, Avon Park (Site No. AP6)

The field investigation program at Site No. AP6 included the installation of one monitoring well, the sampling and analysis of three existing wells plus the new well, and the collection and analysis of surface water and sediment samples from three locations.

One upgradient monitoring well was installed at Site No. AP6 to a depth of 20 feet. The well was completed within the sandy sediments of the surficial aquifer. Visual examination of samples and cuttings and monitoring with an HNU organic vapor detector during drilling did not indicate the presence of contaminants. Groundwater levels were measured during October 1986 and are shown on Figure 4.12 along with flow directions.

Groundwater and surface water samples were collected and analyzed for purgeable halocarbons, purgeable aromatics, base/neutral and acid extractable organics, petroleum hydrocarbons, and metals (Table 4.16). Groundwater samples contained organics in the following concentrations: bis(2-ethylhexyl)phthalate was reported in samples from AP6-1 at 25 ug/L and in AP6-3 at 32 ug/L, and di-n-butylphthalate was reported in all four groundwater samples ranging from 5 ug/L to 10 ug/L. Petroleum hydrocarbons were found in surface water sample AP6-SW1 at 0.34 mg/L.

FIGURE 4.12

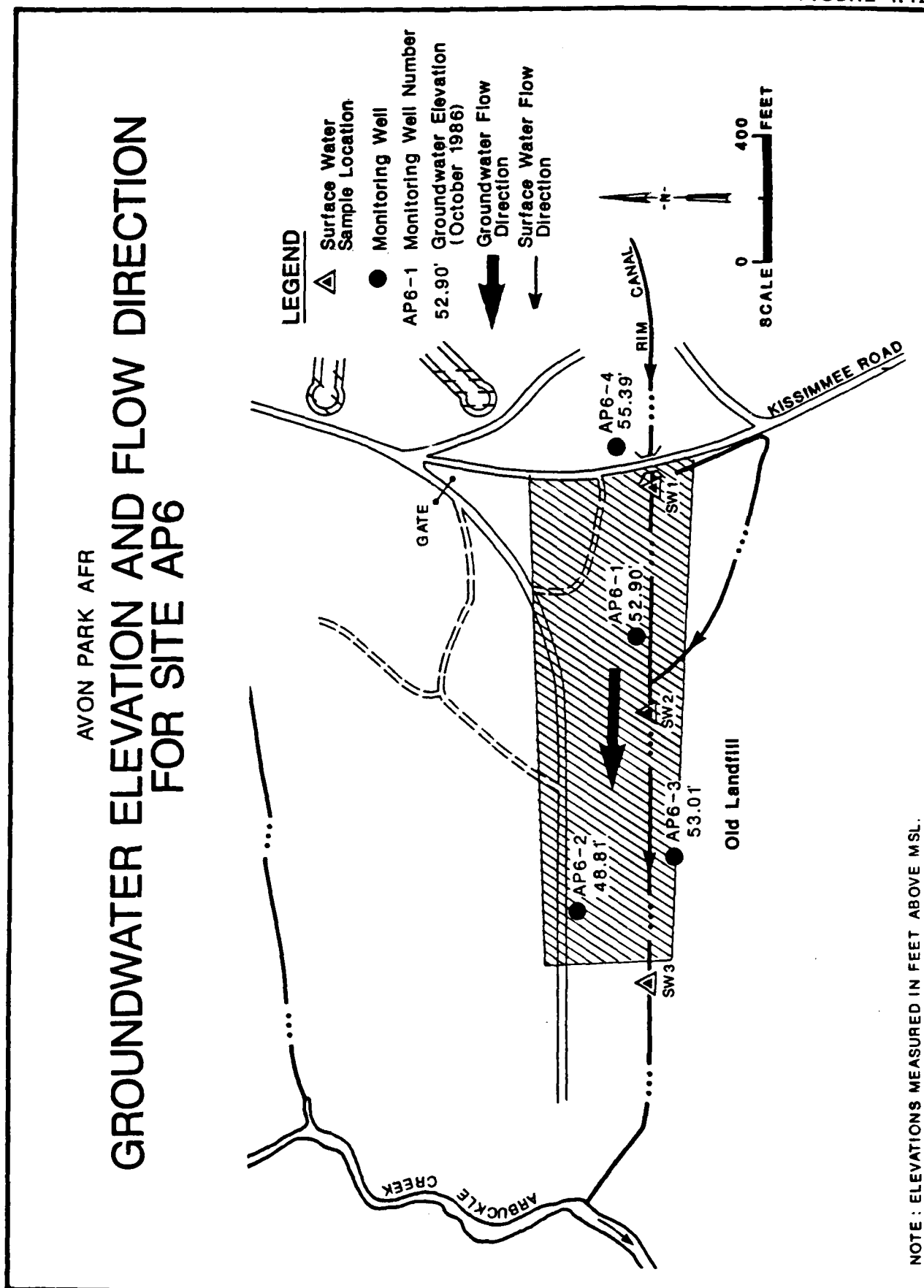


TABLE 4.16
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR GROUNDWATER AND SURFACE WATER SAMPLES FROM AVON PARK SITE NO. AP6
October 1986

PART A: LABORATORY RESULTS

Sample Identifier	Purgeable Halocarbons (E601) (ug/L)	Purgeable Aromatics (E602) (ug/L)	Base/Neutral and Acid Extractable Organics (E625) (ug/L)	Petroleum Hydrocarbons (E418.1) (mg/L)	Metals Scan ^{a, c} (E200.7/245.1) (mg/L)
AO AP6-1 GW ES	ND	ND	Bis(2-ethylhexyl) phthalate - 25 Di-n-butyl phthalate - 10	ND	Aluminum - 11 Calcium - 53 Iron - 6.0 Magnesium - 9.3 Manganese - 0.15 Potassium - 9.5 Silica - 26 Sodium - 12 Vanadium - 0.08
AO AP6-2 GW FS	ND	ND	Di-n-butyl phthalate - 5	ND	Aluminum - 4.6 Barium - 0.15 Calcium - 27 Copper - 0.22 Iron - 120 Magnesium - 29 Potassium 1.9 Selenium 0.01 Silica - 16 Sodium - 40
AO AP6-3 GW ES	ND	ND	Bis(2-ethylhexyl) phthalate - 32 Di-n-butyl phthalate - 9	ND	Aluminum - 14 Barium - 0.06 Calcium - 37 Iron - 5.7 Potassium - 13 Silica - 36 Sodium - 14 Magnesium - 8.0
AO AP6-4 GW FS	ND	ND	Di-n-butyl phthalate - 5	ND	Aluminum - 11 Barium - 0.06 Calcium - 14 Iron - 8.8 Magnesium - 4.4 Potassium - 0.95 Silica - 36 Sodium - 7.0 Vanadium - 0.11
AO AP6-SW1 ES	ND	ND	ND	0.14	Calcium - 8.5 Iron - 2.6 Magnesium - 3.0 Potassium - 1.5 Silica - 11 Sodium - 12
AO AP6-SW2 ES	ND	ND	ND	ND	Calcium - 0.0 Iron - 4.8 Magnesium - 3.2 Potassium - 2.6 Silica - 12 Sodium - 13
AO AP6-SW3 FS	ND	ND	ND	ND ^b	Calcium - 9.1 Iron - 3.2 Magnesium - 3.2 Potassium - 2.8 Silica - 11 Sodium - 13

ND - No compound detected above detection limits.

a - Metals scan included metals and detection limits listed in Table I.2.

b - Average of analyses of a field sample and an internal duplicate (or) sample.

c - To meet the target detection limits, five metals were analyzed by graphite furnace AAS instead of ICPS:
As(E206.2), Sb(E204.2), Se(E270.2), Pb(E233.2), Mn(E246.2).

TABLE 4.16
(Continued)
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR GROUNDWATER
AND SURFACE WATER SAMPLES FROM AVON PARK SITE NO. AP6
October 1986

PART B: FIELD MEASUREMENTS

Avon Park Site No. AP6	pH	Conductivity (umhos/cm)	Temperature (C°)
AO AP 6-1 GW ES	6.3	386	27
AO AP 6-2 GW ES	5.6	1036	25
AO AP 6-3 GW ES	5.6	248	26
AO AP 6-4 GW ES	5.5	111	26
AO AP 6-SW1 ES	6.5	144	24
AO AP 6-SW2 ES	6.1	177	24
AO AP 6-SW3 ES	6.1	160	25

The metals scan indicated the presence of various metals in all water samples (Table 4.16). Field analyses showed pH of groundwater samples ranging from 5.5 to 6.3 and for surface water samples ranging from 6.1 to 6.5. Conductivity values of groundwater samples ranged from 111 umhos/cm to 1036 umhos/cm. Conductivity values for surface water samples ranged from 144 umhos/cm to 177 umhos/cm.

Sediment samples were collected from three locations at Site No. AP6 (Figure 4.12). These samples were analyzed for volatile organics, semivolatile organics, petroleum hydrocarbons, and EP toxicity metals. Table 4.17 is a summary of chemical analysis results on sediments at Site No. AP6. Di-n-butyl phthalate was found at 0.63 mg/kg in the sample from location SD-1. No other compounds were found in the sediments at this site.

4.1.11 Recent Landfill, Avon Park (Site No. AP7)

The field investigation program at Site No. AP7 included the drilling and installation of an upgradient monitoring well, and the collection and analysis of groundwater samples from three existing wells plus the new well. The new monitoring well was installed upgradient of the site (Figure 4.13) at a depth of 20 feet in the sandy sediments of the surficial aquifer. Visual examination of cuttings and split spoon samples, and monitoring with an HNU organic vapor detector during drilling, did not reveal the presence of any contaminants. Groundwater elevation measurements were made during October 1986 and are shown on Figure 4.13 along with groundwater flow directions.

Groundwater samples were collected from the four wells and analyzed for purgeable halocarbons, purgeable aromatics, base/neutral and acid extractable organics, petroleum hydrocarbons, and metals (Table 4.18). Bis(2-ethylhexyl) phthalate was found in sample AP7-2 at 26 ug/L, in sample AP7-3 at 71 ug/L, and in sample AP7-4 at 15 ug/L. Various metals were found in all samples (Table 4.18). No other compounds were found in samples collected at Site No. AP7. Field analyses results show pH ranging from 6.0 to 6.4 and conductivity values ranged from 232 umhos/cm to 449 umhos/cm.

4.1.12 Army Test Area, Avon Park (Site No. AP9)

The field investigation at Site No. AP9 consisted of the collection and analysis of ten shallow soil samples. The samples were collected at

FIGURE 4.13

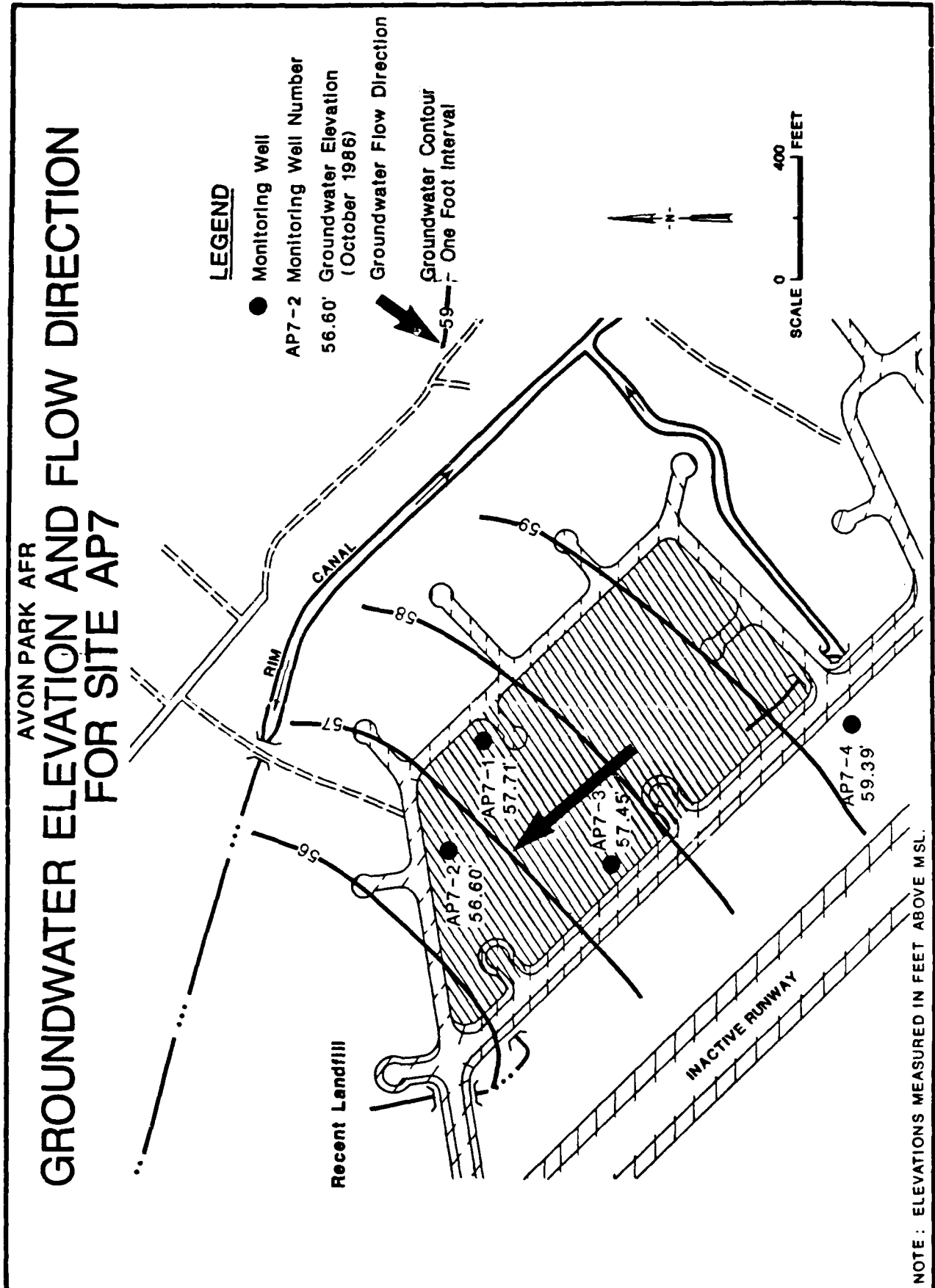


TABLE 4.17
SUMMARY OF CHEMICAL ANALYSIS RESULTS
FOR SEDIMENT SAMPLES FROM AVON PARK SITE NO. AP6
OCTOBER 1986

Sample Identifier	Volatile Organics (SW 5030/8240) (mg/kg dry weight)	Semivolatile Organics (SW 3550/8270) (mg/kg dry weight)	Petroleum Hydrocarbons (SW 3550/E 418.1) (mg/kg dry weight)	Metals (SW 1310/6010, 7471) ^a (mg/L)
AO AP6-SD1 ES	ND	Di-n-butyl phthalate -0.63	ND	ND
AO AP6-SD2 ES	ND	ND	ND	ND
AO AP6-SD3 ES	ND	ND	ND	ND
AO AP6-SD4 ES (Duplicate of AP6-SD3)	ND	ND	ND	ND

ND - Not detected.

a - To meet the target detection limits, three metals were analyzed by graphite furnace AAS instead of ICPEES:
As(SW 7060), Se(SW 7740), Pb(SW 7421).

TABLE 4.1A
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR GROUNDWATER SAMPLE
FROM AVOH PARY SITE NO. AP7

PART A: LABORATORY RESULTS

OCTOBER 1986

Sample Identifier	Purgeable Inlocarbons (E601) (ug/L)	Purgeable Aromatics (E602) (ug/L)	Base/Neutral and Acid Extractable Organics (E625) (ug/L)	Hydrocarbons (E419.1) (mg/L)	Metals Scan ^{a,d} (E200.7/245.1) (mg/L)
AC AP7-1 GW ES	ND	ND	ND	ND	Aluminum-19 Barium-0.05 Calcium-64 Iron-7.9 Magnesium-1.4 Potassium-0.34 Silica-58 Sodium-3.1
AC AP7-2 GW ES	ND	ND	Bis(2-ethylhexyl) phthalate-7 Di-n-butyl phthalate-7	ND	Aluminum-16 Barium-0.09 Calcium-64 Iron-34 Magnesium-5.8 Potassium-1.2 Silica-85 Sodium-24 Vanadium-0.09
AC AP7-3 GW ES	ND ^c	ND ^c	Bis(2-ethylhexyl) phthalate-71 Di-n-butyl phthalate-11	ND	Aluminum-12 Barium-0.09 Calcium-68 Copper-0.12 Iron-86 Magnesium-3.4 Potassium-0.86 Silica-43 Sodium-4.6 Vanadium-0.12
AC AP7-4 GW FS	ND	ND	Bis(2-ethylhexyl) phthalate-17 Di-n-butyl phthalate-15	ND ^c	Aluminum-7.6 Calcium-45 Copper-0.08 Iron-15 Lead-0.01 Magnesium-14 Barium-0.13 Potassium-1.5 Selenium-0.01 Silica-75 Sodium-28 Vanadium-0.09
AC AP7-5 GW FS	ND	ND	Bis(2-ethylhexyl) phthalate-26 Di-n-butyl phthalate-12	ND	Nickel - 0.05 Potassium - 1.8 Selenium - 0.01 Silica - 95 Sodium - 28 Vanadium-0.12 Manganese-0.05

ND - Not detected.

a - Metals scan includes metals and detection limits listed in Table 1.2.

c - Average of analyses of a field sample and an internal duplicate (see sample).

d - To meet the target detection limits, five metals were analyzed by graphite furnace AAS instead of ICP-AES. As(E200.2), Sb(E200.2), Se(E270.2), Pb(E213.2), Mo(E246.2)

TABLE 4.18 (Cont.)
SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR GROUNDWATER SAMPLES
FROM AVON PARK SITE NO. AP7

PART 8: FIELD MEASUREMENTS

Avon Park Site No. AP7	pH	Conductivity (umhos/cm)	Temperature (C°)
AC AP7-1 GW ES	6.4	232	25
AC AP7-2 GW ES	6.2	449	25
AC AP7-3 GW ES	6.4	270	25
AC AP7-4 GW ES	6.0	319	25

a depth of 0.5 feet at various locations within the grassy areas of the auxiliary airfield (Figure 4.14). The samples were analyzed for 2,3,7,8- TCDD (dioxin) and chlorinated herbicides (Table 4.19). No compounds were detected in the samples from Site No. AP9.

4.2 CRITERIA FOR DETERMINING SIGNIFICANCE OF RESULTS

The presence of contaminants in the environment due to past waste handling or disposal practices does not mean the contaminants pose a significant (unacceptable) threat to human health or the environment. To ensure that resources for further investigation and remedial actions are efficiently committed, priorities must be established based on estimates of risk to human health and the environment. The objective of this subsection is to present criteria and standards for determining the significance of the results presented in Subsection 4.1, so that more accurate estimates of risk can be made. Where applicable regulatory standards and guidelines exist, these are used as the criteria for determining significance. Where such regulations do not exist, established scientific principles must be used to develop criteria for determining the significance of contaminants detected.

4.2.1 Established Criteria for Surface Water

The State of Florida has established general classes of surface water for which water quality criteria are available (Florida Administrative Code (FAC), Section 17-3). For the MacDill AFB and Avon Park AFB Phase II, Stage 2 study, the water quality criteria for three classes are applicable:

1. General - includes all surface waters except within zones of mixing,
2. Class II - surface waters for shellfish propagation or harvesting, and
3. Class III - surface waters for recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife.

The surface waters of the State of Florida are classified in FAC Section 17-3.161. At MacDill AFB, Class II waters lie along the southern shore of the peninsula from Gadsden Point west to the base boundary and landward to the mean high tide line. As shown on Figure 4.15, Class II waters lie near Sites 3, 9, 5-8, 11, and 16. All other

FIGURE 4.14

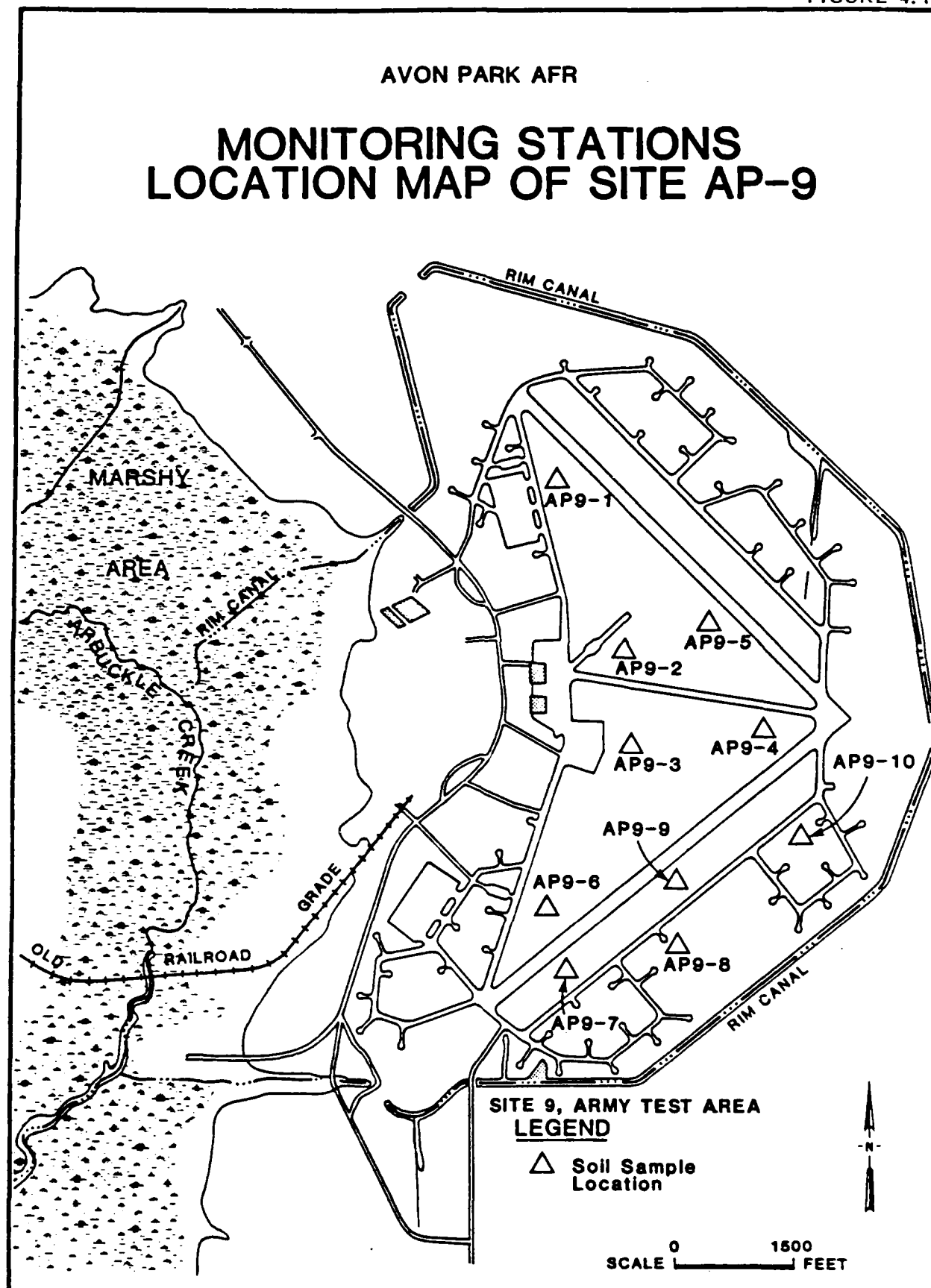
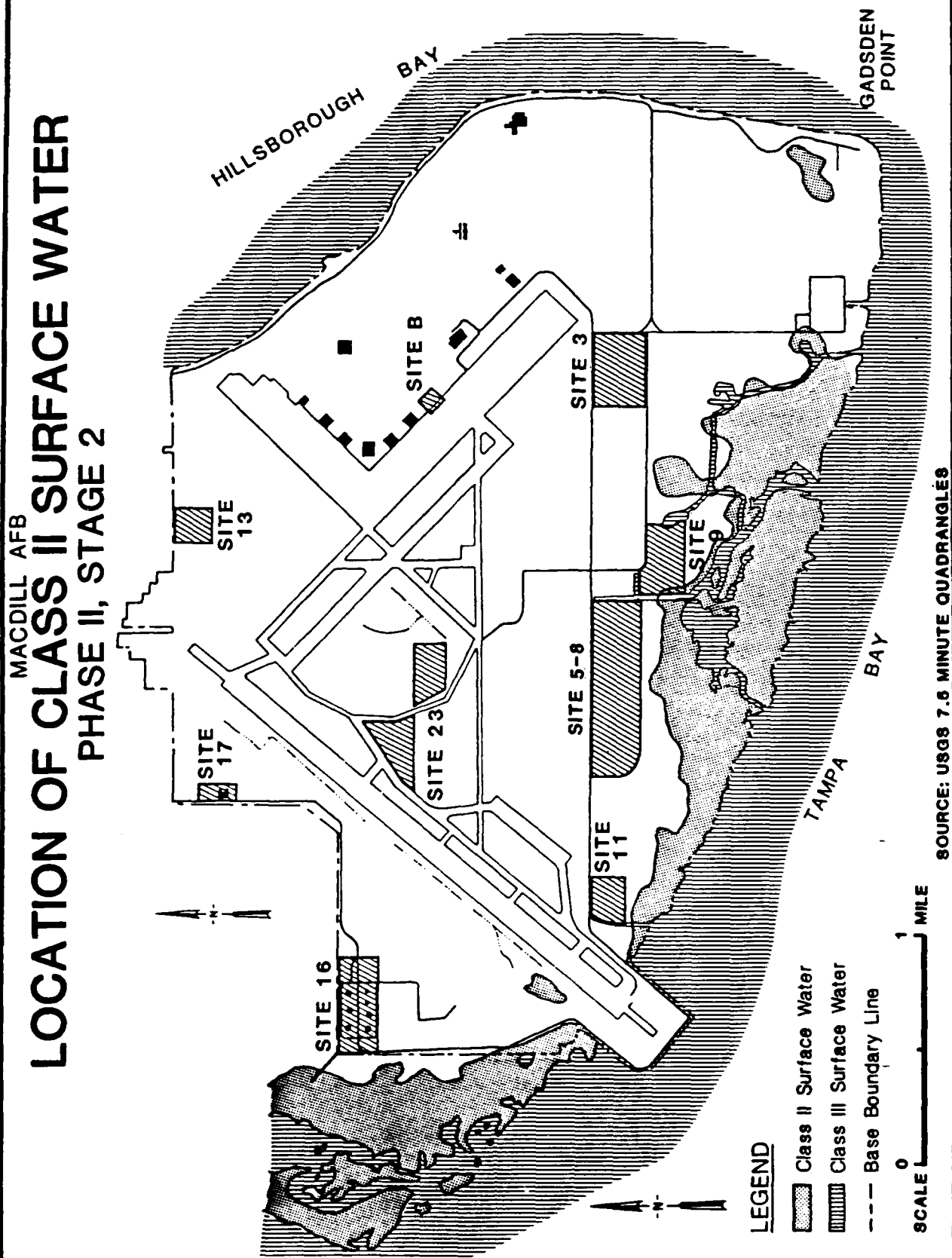


TABLE 4.19
SUMMARY OF CHEMICAL ANALYSIS RESULTS
FOR SURFACE SOILS SAMPLES FROM AVON PARK SITE NO. AP9
OCTOBER 1986

Sample Identifier	2,3,7,8-TCDD Dioxin (SW 8280) (mg/kg)	Chlorinated Herbicides (SW 3550/8150) (mg/kg dry weight)
AA AP9-SS1 ES	ND	ND
AA AP9-SS2 ES	ND	ND
AA AP9-SS3 ES	ND	ND
AA AP9-SS4 ES	ND	ND
AA AP9-SS5 ES	ND	ND ^a
AA AP9-SS6 ES	ND	ND
AA AP9-SS7 ES	ND	ND
AA AP9-SS8 ES	ND ^a	ND
AA AP9-SS9 ES	ND	ND
AA AP9-SS10 ES	ND	ND
AA AP9-SS11 ES (Duplicate of AA AP9-SS8)	ND	ND

ND - Not detected.

a - Average of analyses of a field sample and an internal duplicate (QC) sample.



surface waters at MacDill AFB and at Avon Park AFR are Class III. The Florida water quality criteria applicable to parameters detected in surface water samples from this Phase II, Stage 2 study are listed in Table 4.20.

In addition to the State of Florida criteria, the U.S. Environmental Protection Agency (EPA) has established criteria for 64 pollutant compounds or categories (EPA, 1980). The EPA water quality criteria applicable to parameters detected in surface water samples from this study are listed in Table 4.21. The EPA criteria are useful to evaluate potential risk to freshwater and saltwater life and to human health, but the criteria have no regulatory effect at this time.

The criteria listed in Tables 4.20 and 4.21 are applied in Section 4.3 of this report to determine the significance of contaminant levels detected in surface water samples from MacDill AFB and Avon Park AFR. These criteria are not applicable to some metals detected in surface water samples, nor to contaminant levels measured in soils and stream sediments. Criteria for these metals and other contaminants are developed in subsection 4.2.3.

4.2.2 Established Criteria for Groundwater

The State of Florida has established various classes of groundwater (FAC, Section 17-3.403). All groundwater units sampled during the Phase II, Stage 2 study are considered Class G-II, potable water containing less than 10,000 mg/L dissolved solids. However, the surficial aquifer is not currently used as a drinking water supply on or near MacDill AFB. Also, as indicated in Section 2.6, groundwater in the Upper Floridan Aquifer beneath MacDill AFB is affected by salt water intrusion. Above 10,000 mg/L dissolved solids, Class G-III criteria would apply, but the three wells drilled into the Upper Floridan for the Phase II, Stage 2 study apparently did not penetrate deeply enough to intersect groundwater containing greater than 10,000 mg/L dissolved solids. Many of the groundwater samples did contain mixtures of fresh water and salt water, with high conductivities suggesting dissolved solids levels in excess of 5,000 mg/L. Therefore, the use of Class G-II water quality criteria is probably conservative.

The State of Florida has established general criteria for all groundwater (FAC, Section 17-3.402) and additional criteria for Class

TABLE 4.20
STATE OF FLORIDA SURFACE-WATER QUALITY CRITERIA
FOR SELECTED PARAMETERS

Parameter	All Surface Water*	Class II Surface Water	Class III Surface Water
Arsenic (mg/L)	0.05	---	---
Lead (mg/L)	0.05	---	0.03 (fresh)
pH**	range 6.0 - 8.5	6.5 - 8.5	6 - 8.5 (fresh) 6.5 - 8.5 (marine)
Aluminum (mg/L)	---	1.5	1.5 (marine)
Iron (mg/L)	---	0.3	1.0 (fresh) 0.3 (marine)
Manganese (mg/L)	---	0.1	---
Selenium (mg/L)	---	0.025	0.025
Oil and Grease (mg/L)	5.0		
Specific Conductance	Shall not be increased more than 100% above background levels, nor more than 50% above background or above 5000 umhos/cm in water ranging between 500 and 5000 umhos/cm.	---	---
Zinc (mg/L)	---	1.0	0.03 (fresh)

* - General criteria for all surface water apply unless a more stringent criterion is established for a given class of surface water.

** - pH may not vary below natural background levels that are below 6.0 or above background levels that exceed 8.5.

Source: FAC, Section 17-30.

TABLE 4.21
SELECTED EPA SURFACE WATER QUALITY CRITERIA

Parameter	Criteria for Freshwater Aquatic Life			Criteria for Saltwater Aquatic Life			Criteria for Human Health	
	Acute Toxicity Level	Chronic Toxicity Level	Maximum Concentration	Acute Toxicity Level	Chronic Toxicity Level	Maximum Concentration	Ingestion of Water (10 ⁻⁶ cancer risk)	Taste & Odor Control
Arsenic (mg/L)	--	--	0.440	0.508	--	--	0.0022	--
Chloroform (ug/L)	28,900	1,240	--	--	--	--	0.19	--
Lead (mg/L)	--	--	0.400	0.668	0.025	--	0.050	--
Selenium (mg/L)	0.760	--	0.260	--	--	0.410	.010**	--
Zinc (mg/L)	--	--	0.570*	--	--	0.170	--	5

* - Assumes a total hardness of 200 mg/L as CaCO₃.

** - Existing drinking water MCL.

G-II groundwater (FAC, Section 17-3.404). The general criteria state that groundwater shall be free of contaminants resulting from man-made discharges that:

1. Are harmful to plants, animals, or organisms in soils,
2. Are carcinogenic, mutagenic, teratogenic, or toxic to humans,
3. Are acutely toxic to indigenous species in surface waters affected by groundwater borne contaminants,
4. Pose a serious danger to public health, safety, or welfare,
5. Create or constitute a nuisance, or
6. Impair the reasonable and beneficial use of adjacent water.

The additional criteria for Class G-II groundwater are the primary and secondary drinking water standards established in FAC Section 17-22.104. These additional criteria are listed in Table 4.22 for parameters detected in groundwater samples.

An important exception to the criteria in Table 4.22 is given in FAC Section 17-3.404(2) which states: "If the concentration for any constituent in the natural unaffected background quality of the groundwater is greater than the stated maximum, or in the case of pH is also less than the minimum, the representative background value shall be the prevailing standard for Class G-II groundwater."

In addition to State of Florida criteria, the EPA (EPA, 1985) has established or proposed Maximum Concentration Limits (MCL's) and Recommended MCL's (RMCL's) for several compounds detected in groundwater samples from MacDill AFB. Both MCL's and RMCL's are applicable to drinking water supplies, and their use for evaluating groundwater at MacDill AFB should therefore be conservative. Table 4.23 lists MCL's or RMCL's that may be used to determine significance of contaminant levels measured during the Phase II, Stage 2 study.

4.2.3 Development of Additional Criteria

State of Florida or USEPA water quality criteria are not available for determining the environmental significance of some contaminants detected in soil or water samples during the Phase II, Stage 2 study at MacDill AFB and Avon Park AFR. In the absence of any established criteria, the significance of contaminant levels may be determined by estimating the potential threat to human health or the environment posed

TABLE 4.22
FLORIDA STANDARDS FOR CLASS G-II GROUNDWATER

Parameter*	Primary Standard	Secondary Standard	Remarks
Arsenic	0.05 mg/L	---	
Barium	1.0 mg/L	---	
Cadmium	0.010 mg/L	---	
Chromium	0.05 mg/L	---	
Lead	0.05 mg/L	---	
Mercury	0.002 mg/L	---	
Selenium	0.01 mg/L	---	
Silver	0.05 mg/L	---	
Sodium	160 mg/L	---	
Total Trihalomethanes (TTHM)	0.100 mg/L	---	TTHM is the sum of concentrations of bromodichloromethane, dibromochloromethane, tribromomethane, and trichloromethane.
1,1,1-Trichloroethane	200 ug/L	---	
1,2-Dichloroethane	1 ug/L	---	
Benzene	1 ug/L	---	
1,2 Dibromoethane (ethylene dibromide)	0.02 ug/L	---	
Copper	---	1 mg/L	
Iron	---	0.3 mg/L	
Manganese	---	0.05 mg/L	
Sulfate	---	250 mg/L	
Zinc	---	5 mg/L	
Dissolved Solids	---	500 mg/L	May be greater if no other MCL is exceeded.
pH	---	6.5 minimum	

* In addition to these parameters, FAC Section 17-3.402 establishes minimum criteria for groundwater. See text for further discussion.

TABLE 4.23
EPA MCL AND RMCL FOR SELECTED COMPOUNDS

Compound	MCL (ug/L)	RMCL (ug/L)
1,1-Dichloroethylene	7*	7
1,4-Dichlorobenzene	750*	750
Ethylbenzene	--	680*
Toluene	--	2,000*
Xylenes	--	440*
Carbon tetrachloride	5	
Chlorobenzene		60
1,1-Dichloroethane		20
trans-1,2-dichloroethene		70

* Proposed (50 FR 219, Nov. 13, 1985)

by the contaminants at a particular site. These estimates must consider the following factors:

- o Mobility (migration potential).
- o Persistence in the environment.
- o Bioaccumulation potential.
- o Toxicity (including toxicity of degradation products).
- o Environmental setting.
- o Environmental loading.

The first four factors listed above are related to the physical and chemical properties of each individual compound (or a group of closely related compounds) as determined by its chemical structure. Because chemical structure is constant and independent of concentration or environmental setting, it is possible to make general predictions regarding a contaminant's mobility, persistence, bioaccumulation potential, and toxicity under a given set of environmental conditions.

The factors of mobility, persistence, bioaccumulation, and toxicity are evaluated below for several contaminants detected in water and sediment samples from MacDill AFB and Avon Park AFR. The importance of the other two factors, environmental setting and environmental loading (including areal extent, depth, and concentrations of contaminants), are discussed for each site in Section 4.3.

The contaminants of concern may be divided into two major groups: metals and organic compounds, which are discussed separately below.

4.2.3.1 Metals

The metals scans of water samples from MacDill AFB and Avon Park AFR indicated detectable levels of eight elements for which applicable water quality criteria or action levels are not available. Some of these are essential to aquatic life -- for example, calcium, magnesium, potassium, and silica. These elements commonly occur at high concentrations in both groundwater and surface water as a result of natural dissolution of minerals. The remaining four metals, aluminum, boron, molybdenum and vanadium, are less concentrated in natural waters because they are either less abundant or the common minerals containing them are less soluble in water.

The proximity of MacDill AFB to Tampa Bay causes surface waters and shallow groundwater to be affected to varying degrees by salt water. Tidally-affected streams have variable salt concentrations depending on

the tidal stage. Shallow groundwater near the bay will mix with salt water beneath the land surface as a result of density difference, dispersion, and fresh water flow into the bay (Cooper et al, 1964). Further from the bay, shallow groundwater may have increased salinity from impacts of salt water spray and higher salinity in rain from the bay. These same factors have little effect on shallow groundwater at Avon Park AFR due to its greater distance from the coast. Because of the trace metal content of sea water (Table 4.24), samples of surface water or groundwater containing more than 10 percent sea water will generally have higher metal concentrations than fresh water.

The amount of sea water in water samples can be estimated using the sodium concentration of the sample. Fresh groundwater and surface water from the Tampa area should have sodium concentrations in the range of 0 to 50 mg/L (Steinkampf, 1983), whereas typical sea water concentrations of sodium are about 11,000 mg/L (Krauskopf, 1979). Because of this large range of concentrations, the percentage of sea water in a water sample can be estimated from its sodium content as follows.

$$\% \text{ SW} = \frac{\text{Na (sample)}}{11,000} \times 100$$

Using the percentage sea water and the metals concentrations presented in Table 4.24, the approximate concentration of various metals due to salt water intrusion can be calculated.

Stream sediment samples from MacDill AFB and Avon Park AFR were analyzed for extractable priority pollutant metals (Table 3.3). These metals are naturally occurring in soils at trace levels. Most are toxic to plants, animals, or man at fairly low concentrations. The primary health risks associated with these metals are derived from chronic exposures through ingestion of contaminated food or water, or inhalation of contaminated dust.

There are no federal or State of Florida standards or guidelines for metals in soils. In such cases, the normal background level of individual metals in soils must be considered. Table 4.25 presents average and range of concentrations for selected metals that occur in uncontaminated soils from across the United States.

TABLE 4.24
CONCENTRATIONS OF SELECTED METALS IN SEAWATER

Metal	Concentration* (mg/L)
Aluminum	0.002
Arsenic	0.0004
Barium	0.021
Boron	4.55
Calcium	422
Cadmium	0.0001
Chromium	0.0003
Copper	0.0007
Iron	0.002
Lead	0.00005
Magnesium	1,322
Manganese	0.0002
Mercury	0.00003
Molybdenum	0.005
Potassium	408
Selenium	0.0002**
Silica	4.38
Sodium	11,020
Vanadium	0.003**
Zinc	0.005

* Source: Nordstrom and others, 1972, unless otherwise noted.

** Source: Krauskopf, 1979.

TABLE 4.25
TOTAL CONCENTRATIONS OF SELECTED METALS
IN UNCONTAMINATED SOILS

Metal	Average Concentration (mg/Kg)	Range of Concentrations (mg/Kg)
Arsenic	6	0.1 - 40
Cadmium	0.5	0.01 - 0.7
Chromium	100	5 - 3,000
Lead	10	2 - 2,000
Selenium	0.2	0.01 - 38
Zinc	50	10 - 300

Source: EPA SW-874 (1980)

Note: Data are for soils distant from known mineral deposits or contamination sites.

Unlike organic compounds, metals are not degradable through biological or chemical actions, and can be considered persistent in the environment. Aqueous concentrations of metallic species can be changed through the activity of microorganisms, thereby changing the metal's mobility. For example, biomethylation of lead and mercury can greatly increase their mobility by increasing solubility and reducing sorption potential.

Most of the metals analyzed for the Phase II, Stage 2 and Stage 3 studies have a high potential for bioaccumulation (Versar, 1979). This factor is important to determining the environmental significance of metal concentrations at MacDill AFB, because of the proximity of several IRP sites to Class II surface water (see Figure 4.15). To assess the importance of this factor, the concentration of each metal should be compared with background levels. Those sediments that contain metals highly elevated above background might pose a threat to aquatic life because of bioaccumulation. Background levels of metals in sediments from Tampa Bay are given in Table 4.26.

The mobility of most of the metals analyzed is quite low, with sorption being the most important process controlling mobility (Versar, 1979). The metals arsenic and selenium, however, form readily soluble anions (AsO_4^{3-} and SeO_3^{2-}) in oxidizing environments. Comparison of water samples with soil samples from the same site will indicate whether metals are mobile within the environmental conditions prevalent at the site.

4.2.3.2 Organic Compounds

Organic compounds were detected in soil, sediment, and water samples from MacDill AFB and Avon Park AFR. The significance of levels of many compounds detected in water samples can be determined using criteria cited in Sections 4.2.1 and 4.2.2. For two additional compounds, 1,1-dichloroethane and chlorobenzene, no State of Florida or federal standards or guidelines exist.

In soil and sediment samples, only bis(2-ethylhexyl) phthalate, di-n-butyl phthalate, and petroleum hydrocarbons were detected. The phthalate esters have been determined not to be environmental contaminants at these sites as will be discussed later. No Florida or EPA criteria exist for petroleum hydrocarbons in soils or sediments. The

TABLE 4.26
RANGES OF METAL CONCENTRATIONS IN TAMPA BAY SEDIMENTS

Metal	Total Concentration (mg/kg)
Arsenic	0.1 - 9.3
Cadmium	0.6 - 3.6
Chromium	60 - 100
Lead	9 - 177
Zinc	31 - 385

Source: Ryan and others, 1986.

organic compounds which constitute most of the petroleum hydrocarbons are generally low in toxicity. The primary human health risk is associated with chronic exposures through ingestion of contaminated food and water. Most compounds measured as petroleum hydrocarbons are relatively persistent in the environment. Biodegradation is the main elimination mechanism, but rates are fairly low, especially for cyclic or aromatic hydrocarbons (American Petroleum Institute, 1986). Complete biodegradation of petroleum hydrocarbons may require many years or even decades.

The potential for migration of petroleum hydrocarbons is moderate to low. Most of the hydrocarbons have negligible water solubilities, low vapor pressures, and high sorption coefficients. For example, n-decane ($C_{10}H_{22}$), a medium molecular weight hydrocarbon, has a water solubility of only 0.009 mg/L and a vapor pressure of 2.7 mm Hg at 20°C (Verschuren, 1983). Its overall soil sorption coefficient (K_{oc}) can be estimated from its solubility (S, in mg/L) using the following equation (Lyman and others, 1982).

$$\text{Log } K_{oc} = -0.55 (\text{Log } S) + 3.64$$

The log K_{oc} of n-decane is thus estimated to be 4.77, indicating a high ratio of amounts adsorbed to amounts dissolved. Other petroleum hydrocarbons are even less soluble in water and should adsorb more strongly than n-decane. The generally high sorption potential associated with petroleum hydrocarbons is the primary reason for concluding their mobility is low. Further, volatile and other organic contaminants will generally have lower mobilities, due to sorption or partitioning of these compounds into the petroleum hydrocarbons coating the soil grains. The significance of this is in proportion to each organic contaminant's octanol-water partition coefficient (K_{ow}); greater immobilization results for compounds with higher values of K_{ow} .

4.2.4 Other Factors Affecting Significance of the Results

A number of surface and groundwater samples from MacDill AFB and Avon Park AFB collected during the first field investigation contained detectable levels of two phthalate esters: di-n-butylphthalate and bis(2-ethylhexyl)phthalate. The observation of phthalates at low

concentrations in environmental samples is not uncommon, and may be a result of contamination during either sampling or analysis.

A second sampling was conducted at MacDill AFB at sites where the phthalate esters were detected. Decontamination procedures for sampling equipment were changed to preclude the potential for introducing these compounds into the water samples. The water used for decontamination was ASTM Type II reagent water prepared by the ES laboratory and analyzed prior to use. The complete decontamination procedure used during the second sampling was as follows:

- o Wash with Alconox detergent and HPLC-grade water.
- o Double rinse with ASTM Type II water.
- o Rinse with pesticide-grade methanol.
- o Rinse with pesticide-grade hexane.
- o Air-dry thoroughly and wrap in aluminum foil.

Surface water and groundwater samples were collected at Sites No. 3, Nos. 5 - 8, No. 9, and No. 17 at MacDill AFB in August 1987. These samples were analyzed for base/neutral and acid extractable organics and no compounds were found in the samples. The phthalate esters were not found during this second round of sampling. Therefore, the reported levels of phthalate esters in the samples from MacDill AFB and Avon Park AFB are not considered to be representative of actual environmental levels.

A number of surface and groundwater samples from MacDill AFB collected during the second field investigation reportedly contained detectable levels of methylene chloride and chloromethane. Analytical data analysis reveals that the peak identified as chloromethane appears on the instrument blank run made during this test series. Due to its presence in the blank and the absence of chloromethane during earlier analyses, it is concluded that chloromethane is a laboratory contaminant. Similarly the presence of methylene chloride, which was not detected in the previous sampling (October 1986), is suspected to be a laboratory contaminant. Under EPA Contract Lab Performance criteria, trace levels of common laboratory solvents, which include methylene chloride, are recognized as being analytical contaminants not necessarily occurring at the site sampled.

In analyzing water samples with a high salt water content, a positive matrix interference problem results for metals analysis. Reported levels of metals in samples with high sodium content may be higher than actual environmental levels. In this study, therefore, levels of selenium, arsenic, and lead at sites influenced by tidal mixing may not be accurate.

4.3 SIGNIFICANCE OF FINDINGS AT INDIVIDUAL IRP SITES

In this subsection, the environmental significance of the analytical results presented in Section 4.1 are discussed, using the criteria established in Section 4.2. The following are general comments that pertain to all sites.

The necessity of considering environmental setting and environmental loading when determining significance of contaminant levels at a site was mentioned in Section 4.2. Many of the water-quality criteria presented in Section 4.2 have partially incorporated an environmental loading factor. The environmental setting at MacDill AFB and Avon Park AFR is another key factor to determining the significance of contaminants detected at many of the IRP sites.

As discussed in Section 2, the surficial aquifers at MacDill AFB and at Avon Park AFR are not used for water supply. In addition, clay-rich confining units generally separate the surficial aquifers from the Upper Floridan Aquifer. Thus, although a downward hydraulic gradient exists, contaminant migration through the confining units should be very limited. The nearest wells in the Upper Floridan downgradient of MacDill AFB are to the south and southeast across Tampa Bay. Any contaminants that enter the Upper Floridan at MacDill AFB will likely be diluted far below detectable levels prior to reaching the wells. Wells in the Upper Floridan at Avon Park AFR are closer to the IRP sites, but the Upper Floridan confining layer in this area is approximately 300 feet thick. Migration of any contaminants that have entered the shallow aquifer into the Upper Floridan is unlikely. For these reasons, contaminants in shallow groundwater at MacDill AFB or Avon Park AFR will not pose a significant risk to human health.

In contrast, the presence of contaminants at IRP sites in close proximity to surface water bodies might pose a threat to the

environment. As stated in Section 2, Sites 3, 9, 5-8, 11, and 16 at MacDill AFB are adjacent to Class II surface waters. Low levels of some contaminants in surface water, soils, or shallow groundwater might threaten these areas, which have been specially designated for shellfish propagation or harvesting. Some contaminants may also threaten the Class III waters near other IRP sites, especially where measured concentrations in surface water samples exceed the State of Florida criteria.

The following subsections discuss the significance of the Phase II, Stage 2 findings at each site. A summary of the findings is presented in Table 4.27.

4.3.1 Former Fuel Storage Area No. 2 (Site B)

No evidence of soil contamination was observed during drilling. Low levels of chloroform (1.4 ug/L), ethylbenzene (12.0 ug/L), and xylenes (1.0 ug/L) were detected in the groundwater sample from MDB-2 during the first sampling. Chlorobenzene (1.1 ug/L) and ethylbenzene (5.3 ug/L) were found in the same well during the second sampling. All levels were below the EPA RMCL for groundwater as given in Table 4.23. Other water samples contained low levels of petroleum hydrocarbons and lead. The levels of petroleum hydrocarbons were well below Florida's general criterion of 5.0 mg/L for surface waters (FAC/7 - 3.061). (There is no specific criterion for petroleum hydrocarbons in groundwater.) The concentration of lead (0.01 mg/L) in well MDB-3 was below the criterion of 0.05 mg/L for Class G-II groundwater (Table 4.22).

The detection of petroleum hydrocarbons and fuel-related organics in groundwater suggests that spills or leaks from previous operations at the site may have occurred. However, the detection of the contaminants at low concentrations and the fact that local groundwater is not used for water supply indicate the contaminants pose a negligible threat to human health. In addition, the site is not close to any surface water areas that might be adversely affected by discharge of groundwater borne contaminants.

4.3.2 Landfill at Dog Kennel (Site No. 3)

No evidence of contamination was observed during drilling at this site, and areas of low resistivity observed in the geophysical survey were attributed to the influence of brackish water in the ditches around the site. Conductivities measured in water samples indicate high dis-

TABLE 4.27
SUMMARY OF FINDINGS BY SITES

Site Number	Site Name	Significant Results and Major Conclusions
Site B	Former Fuel Storage Area No. 2	Fuel related contaminants were found at trace concentrations in the upgradient monitoring well. The abandoned tanks at this site need to be addressed (removal or continued monitoring).
Site No. 3	Landfill at Dog Kennel (DK)	No significant contamination found at this site.
Site No. 5-8	Past Landfills (PL)	Purgeable halocarbons and purgeable aromatics detected in two groundwater samples from the same well and one surface water sample.
Site No. 9	Recent Landfill (RL)	Benzene detected and confirmed in one well and chromium detected in another well at the site.
Site No. 11	Chemical Munitions Burial Area (CM)	No significant contamination found at this site. The reported burial areas have not been located or investigated.
Site No. 13	Old Creosote Pit (CP)	No contamination found at this site.
Site No. 16	Fuel Tank Farm (FT)	No significant contamination was found at this site. Groundwater has not been investigated.
Site No. 17	Drum Storage Area (DS)	Purgeable halocarbons and purgeable aromatics were confirmed in one downgradient well.

TABLE 4.27
SUMMARY OF FINDINGS BY SITES
(Continued)

Site Number	Site Name	Significant Results and Major Conclusions
Site No. 23	Fire Training Area (FA)	Purgeable aromatics (fuel related compounds) were detected in wells near the active and inactive burn pits. Petroleum hydrocarbons were detected in the surficial aquifer and in the Floridan Aquifer. A possible continuing source of contamination was identified.
Site No. AP6	Old Landfill, Avon Park AFR	No significant contamination was found at this site.
Site No. AP7	Recent Landfill, Avon Park AFR	No significant contamination was found at this site.
Site No. AP9	Army Test Area, Avon Park AFR	No contamination was found at this site.

solved solids occur in both groundwater and surface water at Site No. 3. The ratio of sodium to potassium concentrations in the water samples (see data in Table 4.2) suggest the dissolved solids are primarily due to mixing of freshwater and seawater, rather than leachate from the old landfill. For example, sample MD3-3 had a Na/K ratio of about 34 which compares favorably with the Na/K ratio of 27 for seawater (see Table 4.25). Previous studies (EPA, 1975) have shown that a Na/K ratio of about 2 is common in landfill leachates.

Water samples containing more than 1000 mg/L Na (10% seawater) are expected to have natural levels of boron, calcium, magnesium, potassium, and sodium higher than in fresh water. The somewhat elevated levels of iron, manganese, and aluminum observed are likely due to collection of unfiltered water samples and subsequent analysis of fine particulates in addition to dissolved species. In the pH range of 6 to 8 these metals normally exist as soluble ions at concentrations of only a few tenths of a milligram per liter, above which they precipitate as oxyhydroxyl-metal compounds (Hem, 1985). Therefore, these metals are not considered to be significant contaminants.

Other metals detected in the groundwater samples included arsenic, lead, vanadium, and selenium. The concentrations of arsenic and lead did not exceed the Florida Standards for Class G-II Groundwater and are not considered environmentally significant.

Vanadium (V) was detected in only one sample. Its concentration was well above the normal maximum of 0.010 mg/L found in most groundwater and surface waters (Hem, 1970), but it was below the level of 1.0 mg/L recommended to protect plants (NAS/NAE, 1972). No Florida or EPA criteria for vanadium have been established, although the EPA (48 FR 45502, Oct. 5, 1983) has asked for public comment on the proposed addition of vanadium criteria to the primary drinking water standards. Because the detected level was below concentrations that might threaten the environment, the surficial aquifer is not used as a water supply, and vanadium did not occur in surface water samples, the level of vanadium detected is not considered significant.

The reported concentrations of selenium in water samples from Site No. 3 are thought to be higher than actual environmental concentrations since the presence of sea salt causes a positive matrix interference in

the selenium analysis. Note that selenium was detected only in samples that contain more than 1,000 mg/L sodium (indicating the sample contains 10% or more seawater). Selenium was not detected in samples that had little or no seawater. Combined with the fact that groundwater in the MacDill AFB area is not used for drinking water supply, the probability that reported selenium values are due to matrix interferences leads to a conclusion that selenium is not a significant contaminant at Site No. 3.

No volatile organics were detected in the groundwater, surface water, or sediment samples. Two base/neutral and acid extractable organics were detected in the first round of groundwater samples, however. These were bis(2-ethylhexyl) phthalate and di-n-butyl phthalate. As discussed in Subsection 4.2.4, and based upon the results of the second sampling, these results are not considered representative of actual environmental levels of phthalates.

Extractable arsenic and selenium were found in sediment samples at insignificant levels (0.01 to 0.03 mg/L). No other extractable metals or organic compounds were found in sediments at Site No. 3.

In summary, no organic compounds or volatile compounds were found in surface water, sediment, or groundwater samples. The various metals detected in the media are not considered significant.

4.3.3 Past Landfills (Site Nos. 5-8)

No evidence of contamination was observed during drilling at Site Nos. 5-8, but the analysis of groundwater samples from the six wells at Site Nos. 5-8 indicated the presence of organic contaminants. Two base/neutral and acid extractable organics were found in all groundwater samples and three of five surface water samples taken during the first sampling. These compounds are bis(2-ethylhexyl) phthalate and di-n-butylphthalate. As discussed in Section 4.2.4 and based upon the results of the second sampling, these contaminants are not considered present in the environment.

Purgeable halocarbons and purgeable aromatics were detected and confirmed in well MD 58-4 during both sampling rounds. Benzene was found at 45 ug/L and at 11 ug/L, which are higher than the State of Florida Criteria for Class G-II groundwater. Carbon tetrachloride was found at 9.4 ug/L which is above the USEPA MCL of 5 ug/L. Other volatile organics were detected in the same groundwater sample at concentrations

below State of Florida criteria and below RMCLs or action levels (Tables 4.22 and 4.23) and are not considered environmentally significant. Also, in surface water station SW1, located in the drainage ditch near well MD58-1, 1,1-dichloroethane was found at a low concentration, below RMCLs. No volatile organic compounds were found in any other surface water or sediment samples at Site Nos. 5-8.

The metals scan of groundwater samples indicated that some salt water occurs in groundwater from wells MD58-1 and MD58-2, due to tidal influences. Various metals associated with salt water were found in these samples (see discussion in 4.3.2). Among other metals detected in groundwater at this site, iron and manganese were found in some samples at concentrations above State of Florida criteria for Class G-II groundwater. However, background concentrations of iron in upgradient wells are above the criteria and the surficial aquifer is not used as a water supply source at MacDill AFB. Therefore, iron and manganese pose no threat to human health or the environment. Lead and selenium were reported at concentrations above their applicable criteria (Table 4.22) in wells MD58-1 and MD58-2, but the high saltwater content in these samples caused positive matrix interferences in the analysis of these metals. Therefore, they are not considered significant.

The metals scan on surface water samples at Site Nos. 5-8 detected concentrations of iron (0.3 to 0.6 mg/L) and selenium (0.07 to 0.08 mg/L) that were slightly higher than the State of Florida criteria for Class II surface waters. The iron concentrations are very slightly above the criteria and below background levels in groundwater and will be diluted even more as they leave the drainage ditch at Site No. 5-8 and enter the mangrove swamp and Tampa Bay. Therefore, these concentrations are not considered a threat to the environment. The surface water at this site is high in saltwater content which causes a positive matrix interference with the selenium analysis. Therefore, the concentration of selenium found in these samples is not considered significant.

No extractable metals were detected in the sediment samples at Site No. 5-8.

In summary, benzene and carbon tetrachloride were detected in groundwater samples from one well at significant concentrations. No

other volatile organics were found at significant concentrations in groundwater, surface water, or sediments. No base/neutral and acid extractable organic compounds found were attributed to contamination of water or sediments at the site. No metals were detected in any samples at concentrations that are considered significant.

4.3.4 Recent Landfill (Site No. 9)

No evidence of contamination was observed during drilling at this site and low resistivity areas identified by geophysical methods were attributed to brackish water in creeks and tidal ponds.

Six wells were sampled and analyzed during both rounds of sampling. Two surface water samples were obtained during the first round and four surface water samples were obtained during the second round. Organic compounds were found in groundwater samples from one well (both rounds of samples) and in one surface water sample. The water sample from well MD9-3 contained low concentrations of benzene (2.4 ug/L and 4.7 ug/L), but these concentrations exceed the State of Florida criteria for Class G-II groundwater. Chloroform was found at 0.47 ug/L in surface water from station SW2. This level is below all criteria for surface water.

No base/neutral or acid extractable organics were found in groundwater, surface water, or sediment samples at significant levels.

In the metals analyses, chromium was detected in one groundwater sample from well MD9-4 (0.11 mg/L). Additionally, various other metals associated with salt water were found in samples from this site (see discussion in 4.3.2). Groundwater samples from Site No. 9 contained levels of iron and reported levels of selenium above the State of Florida criteria for groundwater. The selenium levels reported were probably due to the interference from high salt water content of the samples, which caused a positive matrix interference during analysis.

Surface water sample analysis results showed selenium at concentrations slightly above State of Florida criteria for Class II surface water. These reported concentrations were probably due to the salt water content of the sample which causes a positive matrix interference in the analysis. The selenium levels are not considered environmentally significant.

Although the concentrations of benzene and chromium are above the Florida Criteria for groundwater, they are not considered significant

threats to human health due to the isolated location of this site, the low concentrations found and the high probability of attenuation in the surficial aquifer.

4.3.5 Chemical Munitions Burial Area (Site No. 11)

Analysis of three surface water samples from Site No. 11 failed to detect any purgeable halocarbons, purgeable aromatics, or base/neutral and acid extractable organics. Elevated sodium levels and Na/K ratios indicated high levels of seawater in these samples. As discussed previously, the seawater caused a positive matrix interference during the analysis of selenium and lead, so that the reported levels of selenium and lead in water samples are not considered a threat to human health or the environment.

During analysis of three sediment samples from the site, no volatile organics or extractable metals were detected. Two base/neutral and acid extractable organic compounds, bis(2-ethylhexyl) phthalate and di-n-butyl phthalate, were found in the sediment samples at levels of 0.55 mg/kg and 0.43 mg/kg, respectively. As discussed previously, these results do not indicate significant environmental contamination.

Although no significant contamination was found, the limited number of samples collected at Site No. 11 was inadequate to establish the presence or absence of contamination over the entire site. Geophysical surveys did not identify any potential burial sites at Site 11.

4.3.6 Creosote Pit (Site No.13)

Observations made during drilling at this site did not indicate the presence of contamination. The ER survey detected several areas of low resistivity, but none of the groundwater samples taken from monitoring wells installed in these areas were found to contain base/neutral or acid extractable organics.

4.3.7 Fuel Tank Farm (Site No. 16)

Analytical results of six surface water and sediment samples from this site indicated no apparent contamination. Aromatic volatiles, EDB, and petroleum hydrocarbons were undetectable in all water samples. Purgeable halocarbons were uniformly undetectable except for one water sample containing a trace level of chloroform (0.6 ug/L). This concentration of chloroform is not considered significant because the level was below the applicable criteria.

Concentrations of lead in surface water samples were below State of Florida criteria, except for sample SW1. The level of 0.06 mg/L measured in this sample is probably due to presence of salt water in the sample, which may have caused a positive matrix interference during analysis. Sediment samples from the site contained between 10 and 100 mg/kg of lead, which is in the low to normal (background) range for uncontaminated soils (Table 4.25). The level of petroleum hydrocarbons in one sediment sample was well below recommended action levels. However, groundwater at this site has not been investigated. This should be completed before it is concluded that no significant contamination is present.

4.3.8 Drum Storage Area (Site No. 17)

No evidence of contamination was observed during drilling at this site. Analysis of groundwater samples and surface water samples indicated low levels of purgeable halocarbons and purgeable aromatics in samples from well MD17-1. Benzene was found during the first round of sampling at 0.9 ug/L which is below the state standard for Class II groundwater. Also found only during the first sampling round were chloroform (0.4 ug/L) and 1,1,1-trichloroethane (8.8ug/L), which are below applicable criteria. Three compounds were found during both sampling events: 1,1-dichloroethane at 110 ug/L and 22 ug/L; 1,2-dichloroethane at 2.3 ug/L and 0.32 ug/L; and 1,1-dichloroethylene at 7 ug/L and 61 ug/L. The levels of 1,1-dichloroethane are above the RMCL of 20 ug/L and the levels of 1,1-dichloroethylene are at or above the RMCL of 7 ug/L. The levels of 1,2-dichloroethane are below the RMCL of 3 ug/L. In summary, organic halocarbons have been detected and confirmed at levels of concern at this site.

Except for phthalate esters in two samples, the analysis results showed base/neutral and acid extractable organics to be undetectable in all water samples from the site. The two phthalate esters were bis (2-ethylhexyl) phthalate (130 to 210 ug/L) and di-n-butyl phthalate (25 ug/L). The compounds were also found in sediments at Site No. 17. As previously discussed, these results are not considered to be representative of actual environmental conditions and are therefore insignificant.

The metals scan of ground water samples did not indicate any metals were above the applicable criteria. The sediment samples contained trace levels of lead, chromium, zinc, and cadmium, but comparison of these levels with levels in uncontaminated soils (Table 4.5) shows lead and cadmium are only slightly above average concentrations, and none of the metals exceeded the normal range of concentrations. No organic compounds were detected in sediment samples at significant levels.

4.3.9 Fire Training Areas (Site No. 23)

No evidence of contamination was observed during the drilling and testing conducted at this site. Analysis of water samples from the 14 wells in the surficial aquifer and the three wells in the Floridan Aquifer indicated undetectable or insignificant levels of lead. One groundwater sample (well MD23-3) contained 22 mg/L total petroleum hydrocarbons, but only two other wells in the surficial aquifer contained detectable levels (0.20 mg/L and 0.50 mg/L). Two of the three Upper Florida Aquifer wells at Site No. 23 also contained low, but measurable levels of petroleum hydrocarbons (0.20 mg/L in MD23-D1 and 0.12 mg/L in MD23-D3). Whether leakage of petroleum hydrocarbons from the fire training area through the clay-confining layer above the Florida Aquifer was responsible for this cannot be determined.

Purgeable halocarbons were detected in only one groundwater sample from well MD23-3. The 72 ug/L of trans-1,2-dichloroethene is above the RMCL of 70 ug/L. Analysis of purgeable aromatics indicated levels of benzene in six surficial aquifer wells above the State of Florida criteria for Class G-II groundwater. Detectable levels of other purgeable aromatics occurred in all six wells, but the levels are not significant when compared to applicable EPA criteria (Table 4.23). Wells MD23-1, MD23-2, and MD23-3 were existing wells within 100 feet of the active burn pit, while wells MD23-4, MD23-5 and MD23-6 were existing wells within the berm of the inactive burn pit. No purgeable aromatics were detectable in samples from new monitoring wells located more than 100 feet from the burn pits. The lack of detectable aromatics in wells in the surficial aquifer more than 100 feet from the burn areas indicates these compounds may not be migrating laterally from the sites. However, there is potential for downward migration into the Upper Floridan Aquifer.

The levels of trans-1,2-dichloroethene and benzene in water samples from the surficial aquifer exceed applicable criteria for groundwater, but there is not current or anticipated use of the resource for water supply. Thus the levels of these compounds in the surficial aquifer do not appear to pose a significant risk to human health. However, a long-term potential exists for migration of these compounds into the Upper Floridan Aquifer, especially if use of the fire training areas continues. A continuing source of contaminants greatly increases the potential for migration into the surface water environment and into the Floridan Aquifer which increases the potential threat to human health and the environment.

4.3.10 Old Landfill at Avon Park AFR (Site No. AP6)

No evidence of contamination was observed during drilling at this site. Analysis of four groundwater and three surface water samples indicated no detectable or significant levels of purgeable halocarbons, purgeable aromatics, or petroleum hydrocarbons.

Two phthalate esters, bis(2-ethylhexyl)phthalate and di-n-butyl phthalate, were found at low concentrations (5 to 32 ug/L) in groundwater samples at Site No. AP6. For reasons discussed in Section 4.2.4, these results are not considered representative of actual environmental conditions and therefore are considered insignificant.

The metals scan for surface water and groundwater samples indicated no metals present above applicable criteria, except for iron (Fe). Iron was found in all water samples at levels above the State of Florida criteria for groundwater and surface water (ranging from 2.6 mg/L to 120 mg/L). The iron level in the upgradient well was 8.8mg/L, and in the upstream surface water sample was 2.6 mg/L. Iron levels in surface water leaving the site was found at 3.2 mg/L. Also, iron levels vary widely in the surficial sand aquifers. However, the level of 120 mg/L is an anomaly and is not representative of background levels. These data indicate that iron levels in background samples are above state standards and surface waters are not being significantly degraded before leaving the site.

No contaminants were found at levels of concern in sediment samples from Site No. AP6.

4.3.11 Current Landfill at Avon Park AFR (Site No. AP-7)

No evidence of contamination was observed during drilling at this site. Analysis of four groundwater samples indicated purgeable halocarbons, purgeable aromatics, and petroleum hydrocarbons were undetectable. Two base-neutral and acid extractable organics were detected at low levels (7 to 71 ug/L) in three of four groundwater samples from Site No. AP7. For reasons previously discussed in Section 4.2.4, these results are not representative of actual environmental conditions and are not considered significant.

The metals scan indicated low and insignificant levels of all metals except iron. The reported iron levels in all groundwater samples, including the upgradient sample, were above State of Florida criteria for Class-II groundwater.

4.3.12 Army Test Area at Avon Park AFR (Site No. AP9)

Analysis of ten soil samples showed no chlorinated herbicides or dioxin (2,3,7,8-TCDD). The soil analyses results indicate there is no apparent contamination at the site that might threaten human health or the environment.

SECTION 5
ALTERNATIVE MEASURES

SECTION 5

ALTERNATIVE MEASURES

This section identifies and discusses the major alternatives for future activities under the Installation Restoration Program at each of the sites investigated, based on the results presented in Section 4. These alternatives can be classified into three categories:

- o No further action.
- o Additional site investigations (IRP-Phase II, Stage 3).
- o Remedial Actions (IRP-Phase IV).

Alternative activities identified within each of these categories are discussed for individual sites, when appropriate.

5.1 FORMER FUEL STORAGE AREA NO. 2 (SITE B)

Petroleum hydrocarbons, fuel related organic compounds, and lead were detected at low levels in samples from monitoring wells at the site. The low contaminant concentrations, the isolated occurrence of the various contaminants, and the lack of groundwater use at MacDill AFB suggest that the contamination at Site B would pose little or no threat to human health or the environment. However, the underground storage tanks at this site should either be monitored (long term sampling of the existing wells at this site) or emptied, excavated and removed to further assure that nothing is leaking from these tanks into the environment. Therefore, the alternative of additional investigations is appropriate for Site B.

5.2 LANDFILL AT DOG KENNEL (SITE NO. 3)

No significant contaminants were found in samples from this site. Therefore, the no further action alternative is appropriate for Site No. 3.

5.3 PAST LANDFILLS (SITE NO. 5-8)

The contaminants found at levels of concern at Site No. 5-8 were volatile organics. Volatile organics, detected and confirmed in two groundwater samples and one surface water sample, were below all criteria except for carbon tetrachloride and benzene, which exceeded MCLs for groundwater. Further investigations should be conducted on the downgradient side of the site in order to more fully characterize the site for assessment of risk.

5.4 RECENT LANDFILL (SITE NO. 9)

Analysis of groundwater samples for the two rounds of sampling confirmed the presence of benzene in Well MD9-3 and chromium in Well MD9-4 at levels above the MCL for groundwater. However, the surficial aquifer is not used as a water supply in this area and the contaminants were not detected in surface waters directly adjacent to the site. Based on the potential for limited risk from this site, it is recommended that additional sampling be conducted to confirm the presence of contaminants and a risk assessment be performed to evaluate the need for additional investigation or remediation.

5.5 CHEMICAL MUNITIONS BURIAL AREA (SITE NO. 11)

This investigation did not confirm the presence of contamination at Site No. 11. Three surface water and sediment samples were collected and analyzed from the area around the suspected site. Although the analysis results did not indicate the presence of any environmentally significant contaminants at the locations sampled, this evidence is not enough to adequately characterize the site. Also, geophysical surveys did not identify areas with buried wastes. Therefore, the no further action alternative is not appropriate.

The additional investigation alternative is most appropriate for Site No. 11. Identification of the locations of landfilled materials is necessary to fully evaluate this site. Areas with buried metallic wastes should be located and action taken to identify the nature of the wastes.

5.6 OLD CREOSOTE PIT (SITE NO. 13)

No contamination was detected in the groundwater at Site No. 13. The alternative of no further actions is the appropriate choice.

5.7 FUEL TANK FARM (SITE NO. 16)

Analysis of surface water and sediment samples from Site No. 16 indicated no significant contamination. However, groundwater was not sampled and analyzed during this investigation. Until the groundwater has been characterized, the no action alternative is not acceptable for Site 16. Therefore, the further investigation alternative is appropriate.

5.8 DRUM STORAGE AREA (SITE NO. 17)

Analysis of samples from both rounds of sampling indicated the presence of purgeable halocarbons at levels above MCLs in Well MD17-1. No contaminants were found in the other groundwater samples or surface water samples. The presence of these organics above MCLs negates the no further action alternative. Further investigations should be conducted to identify the source, to determine the extent of contamination and the potential threat to human health and the environment.

5.9 FIRE TRAINING AREA (SITE NO. 23)

Fuel related organic compounds were detected at levels of concern in groundwater samples from both the active and inactive fire training areas. Benzene, toluene and ethylbenzene were detected and confirmed in the existing wells located in the burn pit areas. The levels of benzene ranged up to 640 ug/L, ethylbenzene up to 350 ug/L, and toluene up to 29 ug/L. The benzene levels are above State of Florida Criteria. The lateral extent of these contaminants did not reach any of the new monitoring wells except for Well MD23-11 which showed only 1.4 ug/L of toluene.

The presence of high levels of organic contaminants in the surficial aquifer negates the no further action alternative. The further investigation alternative to define the lateral extent of contamination and to determine the significance of contamination in the Floridan Aquifer would seem justifiable. Additionally, surface water and

sediments from drainage ditches around both fire training areas were not sampled to determine if groundwater moving into the surface water environment is carrying contaminants.

Another alternative is to move directly to site remediation. Based upon the contamination known to exist, and the potential for surficial aquifer leakage to the Floridan Aquifer, remedial action will eventually be necessary to eliminate the contaminant source or reduce the potential for migration into either the Floridan Aquifer or the surface water environment. The evidence is sufficient to conclude the remedial action alternative is most appropriate at Site No. 23.

5.10 OLD LANDFILL, AVON PARK (SITE NO AP6)

No significant contamination was discovered at Site No. AP6. Therefore, the no further action alternative is appropriate for this site.

5.11 CURRENT LANDFILL, AVON PARK AFR (SITE NO. AP7)

No significant contamination was detected at Site No. AP7. Therefore, the no further action alternative is appropriate for this site.

5.12 ARMY TEST AREA, AVON PARK AFR (SITE NO. AP9)

No contamination was detected at Site No. AP9. The no further action alternative is the appropriate choice for this site.

SECTION 6
RECOMMENDATIONS

SECTION 6

RECOMMENDATIONS

This section presents recommendations for the three categories of sites at MacDill AFB and Avon Park AFR, based on results of the IRP Phase II, Stage 1 and Stage 2 investigations. Category I sites are those for which no further action is required. Data for these sites is sufficient to conclude that no significant threat to human health or the environment exists. Category II sites are those which require additional monitoring or investigation to assess the extent of current or future contamination. Category III sites are those which will require remedial actions. Data for these sites is considered sufficient to characterize the extent of contamination or they indicate an immediate threat to human health or the environment. Recommendations for the nine sites investigated at MacDill AFB and the three sites at Avon Park AFR are summarized in Table 6.1.

6.1 CATEGORY I SITES: NO FURTHER ACTION

No significant contamination was found at several of the sites, as discussed in Sections 4.0 and 5.0. These sites are not considered to pose a threat to human health or the environment and require no further actions. Individual sites included in this category are:

- o Landfill at Dog Kennel (Site No. 3)
- o Old Creosote Pit, (Site No. 13)
- o Old Landfill, Avon Park AFR (Site No. AP6)
- o Recent Landfill, Avon Park AFR (Site No. AP7)
- o Army Test Area, Avon Park AFR (Site No. AP9)

6.2 CATEGORY II SITES: ADDITIONAL INVESTIGATIONS

Six sites at MacDill AFB fall into Category II and require additional work to characterize the presence of contamination and the

TABLE 6.1
SUMMARY OF RECOMMENDATIONS BY CATEGORY

Site Category	Site Identifier	Recommendations	Rationale for Recommendation
Category I	Site No. 3	No further action	No significant contamination was found to warrant additional study or remediation.
	Site No. 13		
	Site No. AP6		
	Site No. AP7		
	Site No. AP9		
Category II	Site No. 5-8	Further investigation	Contaminants were detected at levels of concern, but the extent of contamination is unknown. Additional work is required to determine if human health or the environment is threatened.
	Site No. 9		
	Site No. 17		
	Site B		
	Site No. 11		
Category III	Site No. 16	Further investigation	No contaminants were detected at levels of concern in samples collected from these sites, but the field work did not adequately evaluate the potential for contamination. Additional work is needed to confirm or deny the presence of potential contaminants at these sites, and whether they are a threat to human health or the environment.
	Site No. 23		
	Phase IV, remedial actions		
Category III	Site No. 23	Phase IV, remedial actions	Contaminants were found at levels of concern. The potential exists for contaminant migration into the Floridan Aquifer. The contaminant source is a continuing threat to the environment.

potential threat to human health or the environment. At three of these sites contaminants were found at levels of concern, but the data were insufficient to determine the extent of contamination. These are Site No. 5-8, Site No. 9, and Site No. 17. The additional investigations recommended for these three sites are described below. Three additional sites were placed in Category II because of the need for additional information to fully characterize the sites. These sites, Site B, Site No. 11, and Site No. 16, require additional work also described below. Table 6.2 summarizes the additional work recommended at these sites.

6.2.1 Site No. 5-8 - Past Landfills

Purgeable organic compounds were detected and confirmed at levels of concern in samples from well MD58-4 and in surface water sample MD58-SW1. The source of this contamination should be identified and the extent of contamination should be defined. Additional investigations should include the installation of five monitoring wells along the downgradient side of the landfills (Figure 6.1). These wells should be completed in the surficial aquifer. One boring should be drilled deeper into the clay layer (approximately 20 feet into clay) to define its thickness. This boring should then be backfilled and completed as a surficial aquifer well. If the clay layer is thin or absent, this boring should be completed as a Floridan Aquifer monitoring well with a surficial aquifer well installed adjacent to it.

The new wells, the existing wells, and the surface water stations should be sampled and analyzed for purgeable organics.

6.2.2 Site No. 9 - Recent Landfill

Benzene and chromium were detected at levels above MCLs at Site No. 9. Based upon the potential for limited risk, additional work should be conducted at this site. All existing wells should be sampled and analyzed for purgeable organics and metals. The surface water should be sampled at low tide in the creeks on the western boundary and north of the landfill (Figure 6.2) and analyzed for the same parameters as the groundwater samples. Based upon the results of this and past samplings, the risk to human health and the environment should be assessed.

6.2.3 Site No. 17 - Drum Storage Area

Organic contaminants were detected at levels above MCLs in groundwater samples from well MD17-1. Additional work should be conducted at

TABLE 6.2
SUMMARY OF RECOMMENDED CATEGORY II INVESTIGATIONS BY SITE

Site Number	Site Name	Description of Additional Field Activities	Description of Additional Analytical Activities
Site No. 5-8	Past Landfills	<p>Installation of five shallow monitoring wells (approx. 20 feet deep) and one boring into the clay confining layer with option of completions in Floridan aquifer.</p> <p>Collection and analysis of eleven groundwater samples and five surface water samples.</p> <p>Risk assessment.</p>	<p>Eleven water samples for purgeable organics (SW8010/8020)</p>
Site No. 9	Recent Landfill	<p>Collection and analysis of six groundwater samples.</p> <p>Collection of four surface water samples at low tide and analysis.</p> <p>Risk assessment.</p>	<p>Ten water samples for purgeable organics (SW8010/8020) and metals (E200.7, E245.1)</p>
Site No. 17	Drum Storage	<p>Installation of two shallow monitoring wells (approx. 20 feet deep).</p> <p>Ten soil borings with split spoon samples.</p> <p>Collection and analysis of six groundwater samples and two surface water samples.</p> <p>Risk Assessment.</p>	<p>Eight water samples for purgeable organics (SW8010/8020)</p> <p>Approximately thirty soil samples for purgeable organics (SW8010/8020)</p>

TABLE 6.2 (Continued)
SUMMARY OF RECOMMENDED CATEGORY II INVESTIGATIONS BY SITE

Site Number	Site Name	Description of Additional Field Activities	Description of Additional Analytical Activities
Site B	Former Fuel Storage Area No. 2	Continued monitoring of existing wells and removal of abandoned underground fuel tanks.	Purgeable organics (SW8010/8020) Petroleum Hydrocarbons (E418.1)
Site No. 11	Chemical Munitions Burial Area	Records search and interviews. Define burial area.	
Site No. 16	Fuel Tank Farm	Installation of three shallow monitoring wells (approx. 20 feet deep). Collection and analysis of three groundwater samples.	Three water samples for purgeable organics (SW8010/8020) and petroleum hydrocarbons (E418.1)

FIGURE 6.1

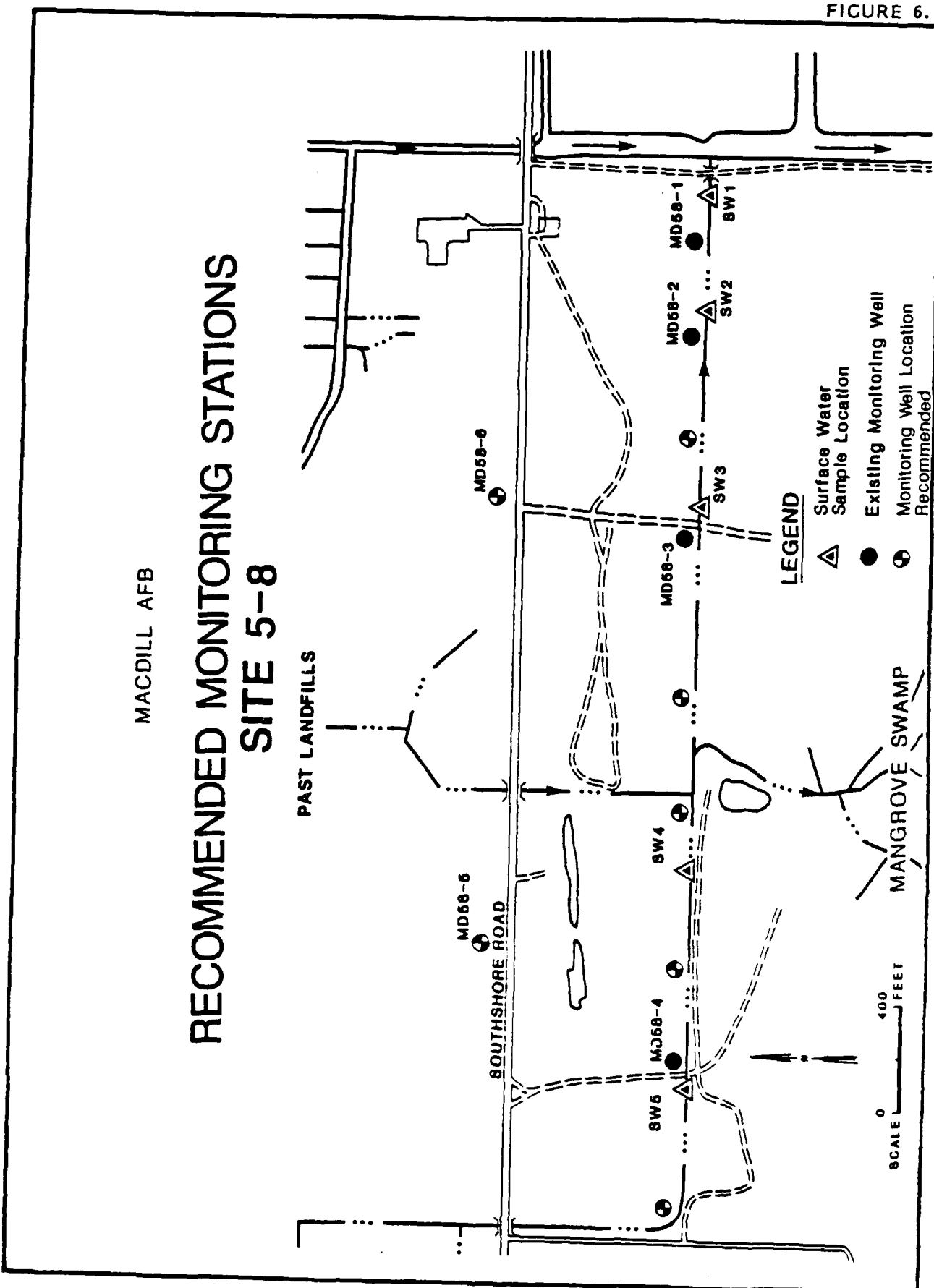
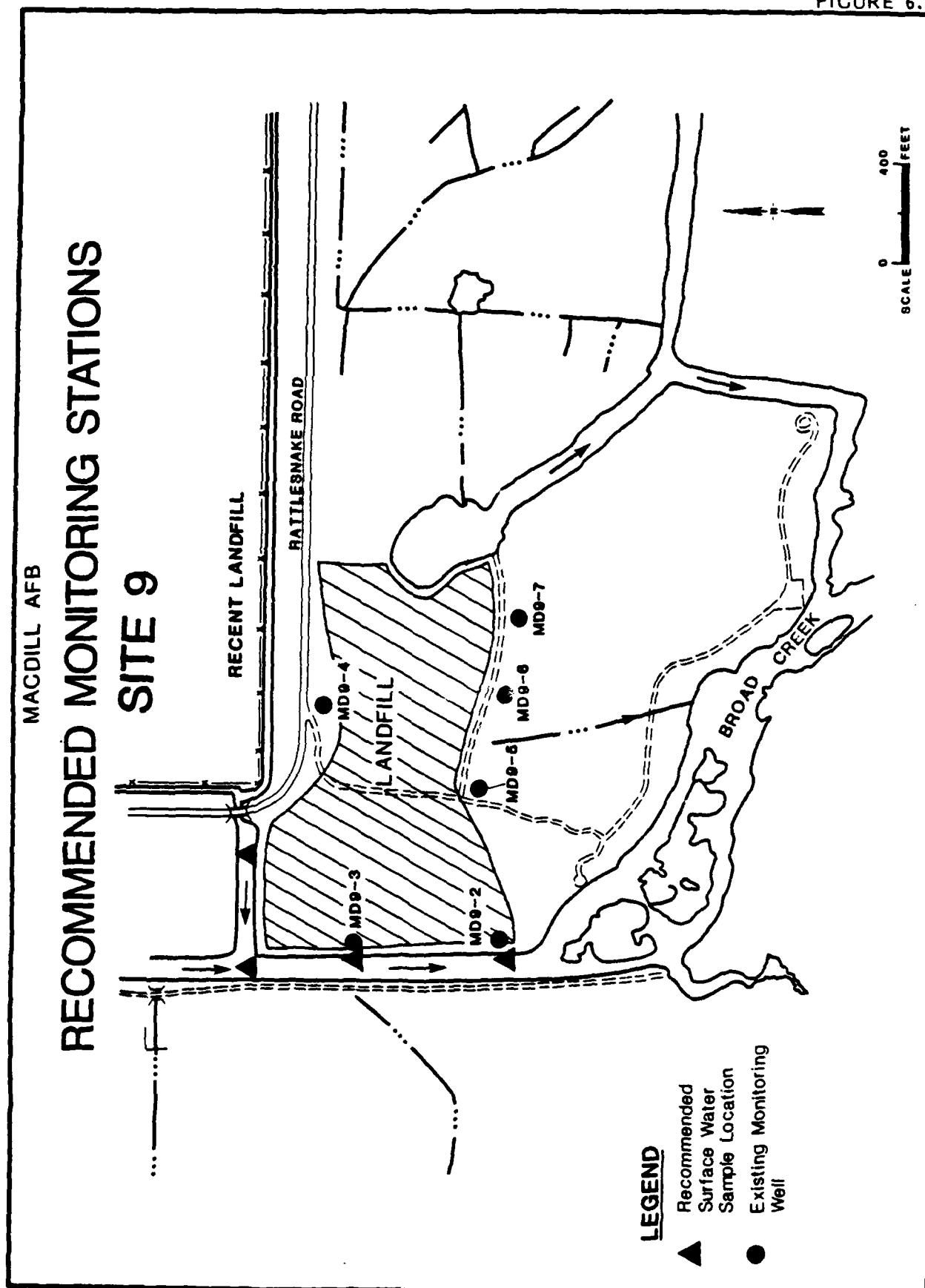


FIGURE 6.2



this site to identify the source of the contaminants, to define the extent of contamination, and to assess the risk to human health and the environment. Two monitoring wells should be installed downgradient of well MD17-1 (Figure 6.3) and completed in the surficial aquifer. Approximately ten soil borings should be drilled to the water table and split spoon samples taken in the drum storage area. New and existing monitoring wells and surface water stations should be sampled and analyzed for purgeable organics. Soil samples from the ten soil borings should be analyzed for purgeable organics. The data should be reviewed and the risk to human health and the environment assessed.

6.2.4 Site B - Former Fuel Storage Area No. 2

Fuel related compounds were found in trace concentrations in samples from Site B. The levels detected were below applicable standards and criteria. However, the presence of the abandoned underground fuel tanks at this site necessitates the need for additional work. Continued monitoring, semi-annually, should be done while the tanks are still in place. The five monitoring wells should be sampled and analyzed for purgeable organics with xylenes, petroleum hydrocarbons, and lead.

The underground storage tanks should be checked for content, emptied, excavated, and removed. The soils should be inspected for visual signs of tank leakage and contamination, sampled and analyzed for petroleum hydrocarbons.

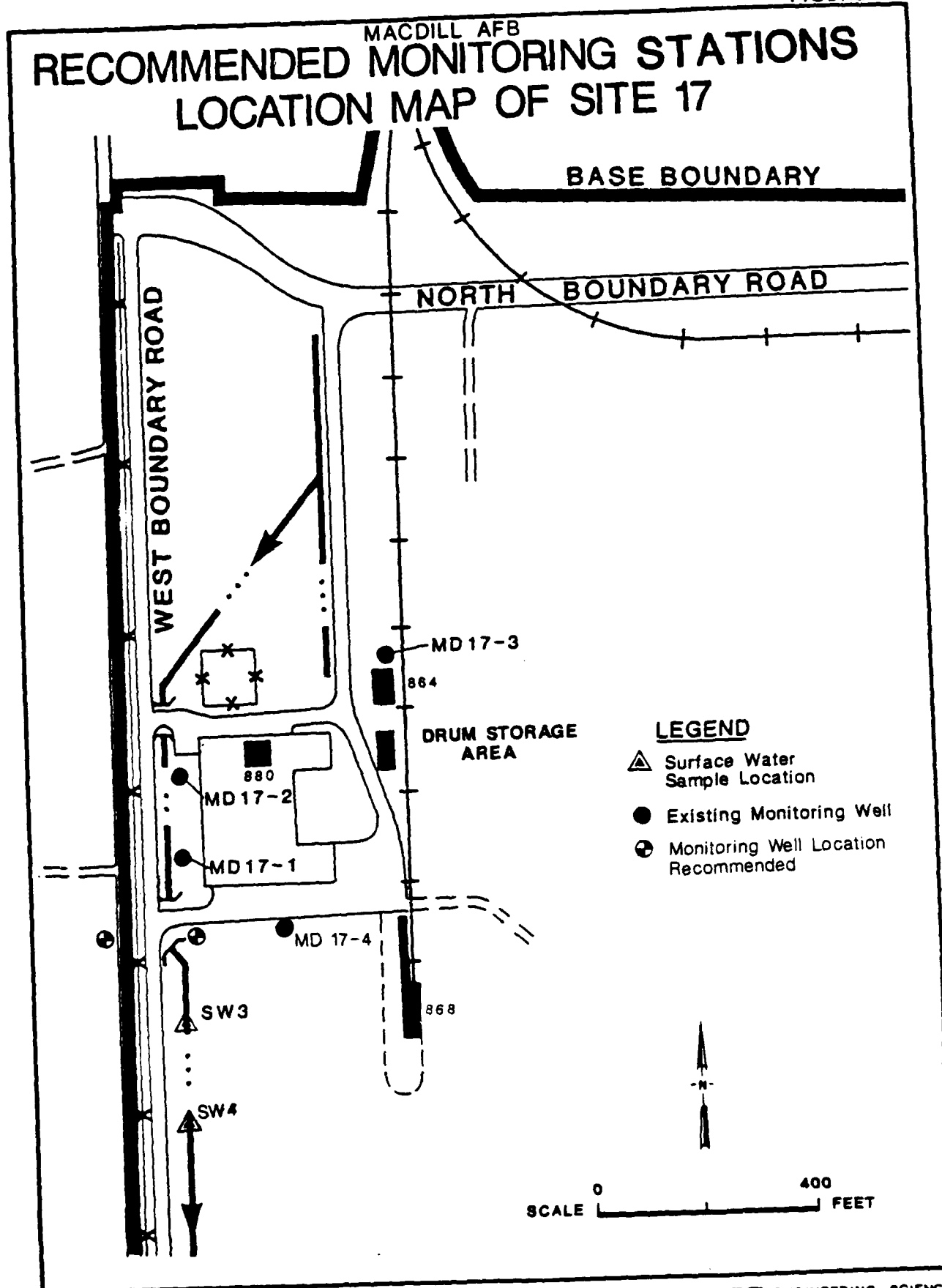
6.2.5 Site No. 11 - Chemical Munitions Burial Area

The Chemical Munitions Burial Area has not been accurately identified and waste burial areas located. Additional work needs to be conducted to identify the area where wastes were dumped, characterize the wastes, and determine the presence or extent of contamination. Additional records searches and interviews should be conducted to determine the location of this site and to identify buried materials. Aerial photographs, if available, should be reviewed. A field program should be proposed based upon the results of the records search and interviews.

6.2.6 Site No. 16 - Fuel Tank Farm

Results of the investigation at Site No. 16 indicated no significant contamination is present in the surface water environment around the site. However, the groundwater system has not been adequately

FIGURE 6.3



investigated. Additional work for this site should include the installation and sampling of three monitoring wells completed in the surficial aquifer outside of the berm surrounding the site (Figure 6.4). The wells should be screened across the water table to intercept any floating contaminants. The samples should be analyzed for purgeable organics with xylenes and petroleum hydrocarbons.

6.3 CATEGORY III SITES: IRP PHASE IV REMEDIAL ACTIONS

Contamination has been confirmed at Site No. 23 in sufficient concentrations to constitute a potential threat to the environment. Fuel related organics were detected in the groundwater around both fire pits. The extent of contamination appears to be well defined, but continuing sources of contaminants could increase the potential for further contaminant migration in the surficial aquifer and into the Floridan Aquifer. For these reasons, Site No. 23 is recommended for remedial action.

Potential remedial action alternatives for Site No. 23 are identified in Table 6.3. Appropriate technologies are also identified. Table 6.4 presents a summary and brief description of the technologies and remedial actions that are considered appropriate for Site No. 23.

MACDILL AFB **RECOMMENDED MONITORING WELL LOCATION MAP OF SITE 16**

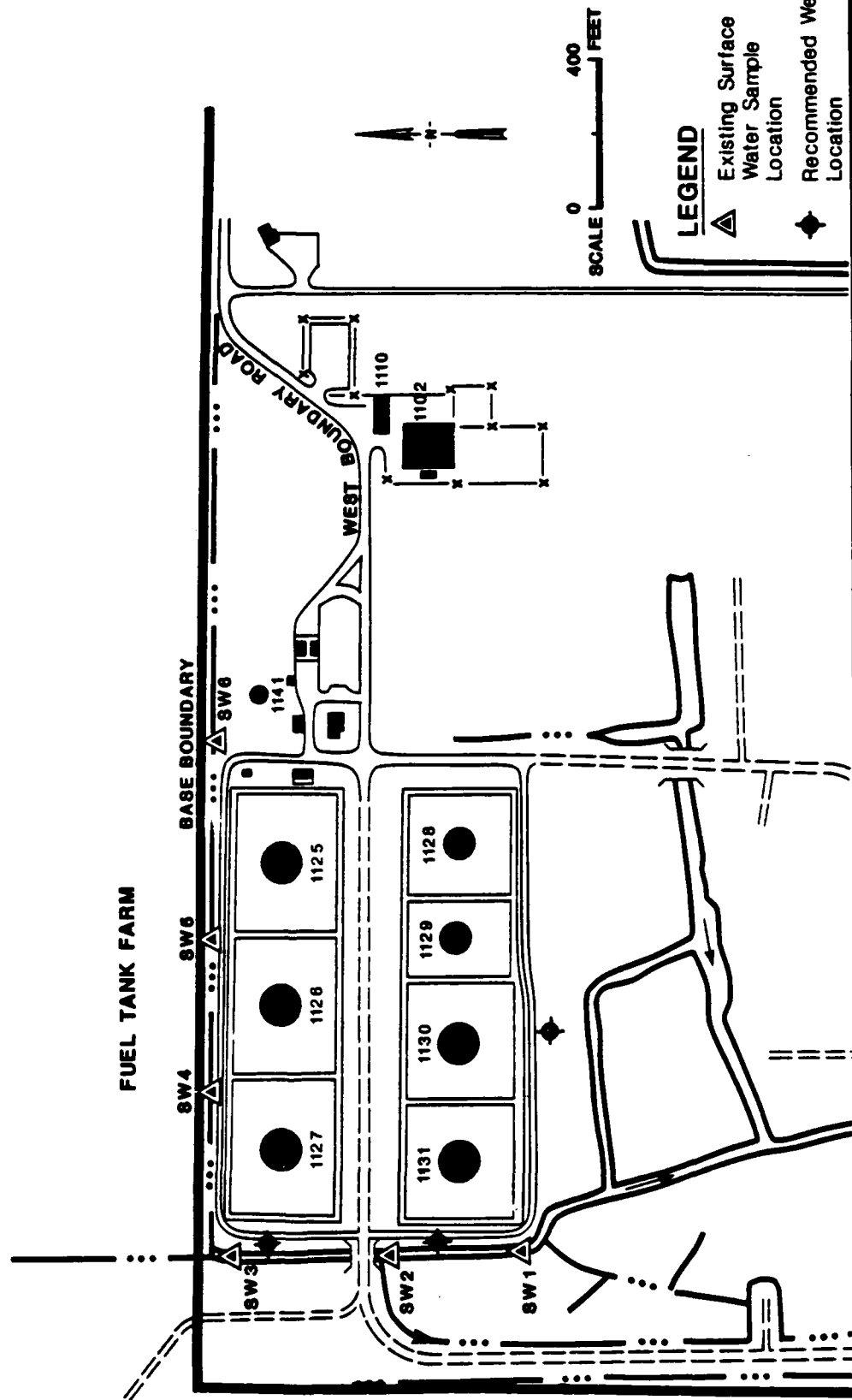


FIGURE 6.4

TABLE 6.3
IDENTIFICATION OF
POTENTIAL REMEDIAL ACTIONS
AT SITE 23, FIRE TRAINING AREA
MACDILL AFB

Media	Type of Remedial Action	Technology
Soil	Removal and Treatment/ Disposal	<ul style="list-style-type: none"> o Excavation o Landfill o Incineration o Thermal Processing o Washing
	In-situ Treatment	<ul style="list-style-type: none"> o Biodegradation o Flushing o Air Stripping o Steam Stripping
	Containment/Migration Control	<ul style="list-style-type: none"> o Capping o Solidification
Groundwater	Recovery and Treatment	<ul style="list-style-type: none"> o Pumping o Activated Carbon o Air Stripping o Biodegradation o Treatment at a POTW
	Containment/Migration Control	<ul style="list-style-type: none"> o Impermeable Barriers o Subsurface Trenches

TABLE 6.4
SUMMARY OF POTENTIAL REMEDIAL ACTIONS
SITE 23, FIRE TRAINING AREA
MACDILL AFB

Technology	Description	Comments
<u>SOILS</u>		
Excavation	Physical removal of contaminated soils for treatment or disposal.	Applicable to both the active and inactive fire training areas (FTA). Construction of a new FTA in the same location would also require excavation.
Landfill	Disposal of excavated soils in an approved hazardous waste facility. Soils may be drummed or disposed of in bulk.	A land ban applies to P-listed solvents in concentrations > 1% and total halogenated organic compounds (HOC) in concentrations > 1000 mg/kg. Neither of these two conditions are expected to apply. Transportation costs would be high considering the distance to existing RCRA facilities.
Incineration	Thermal contaminant destruction by combustion/oxidation at very high temperatures.	A proven technology for destruction of the contaminants identified. Consideration must be given to disposal of the remaining soil ash. Given estimated soil volumes, an on-site mobile unit should be more cost-effective than transportation to an off-site facility.
Thermal Processing	An innovative technology where excavated soils are placed in a heat exchanger (thermal processor) and heated to volatilize organics. Vapors are treated in an after-burner or otherwise treated as necessary.	Treatability testing would be required to determine effectiveness and design parameters. Treated soils could be returned to the excavated areas.

TABLE 6.4 (Continued)
SUMMARY OF POTENTIAL REMEDIAL ACTIONS
SITE 23, FIRE TRAINING AREA
MACDILL AFB

Technology	Description	Comments
<u>SOILS (Continued)</u>		
Washing	Excavated soils are screened and placed in a flotation cell with wash water. A mechanical impeller provides mixing.	Surfactants may be used to enhance contaminant removal as determined by treatability testing. Withdrawn leachate would require treatment. Washed soils could be returned to the excavated areas.
Biodegradation	In-situ treatment using microorganisms to biodegrade the organic contaminants. Air may be mechanically added to aid microbial decomposition.	Contaminant types, concentrations, shallow depth (to groundwater), and warm climate all appear to be favorable conditions.
Flushing	In-situ percolation of water through contaminated soils to solubilize adsorbed compounds and reduce residual concentrations.	Provides an alternative to excavation by reducing the extent of source contamination. Recovery would be achieved through a well point system. Solvent flushing is not recommended given the shallow groundwater table and potential for further groundwater contamination.
Air Stripping	In-situ mechanical injection of clean air into contaminated soils to volatile organics. Air is withdrawn and vented to the atmosphere or to an emission control system (e.g., activated carbon adsorption) depending on volatile concentrations.	Most effective for loose, sandy soils well above the groundwater table. Ultimate effectiveness has not been established. Could be done in conjunction with biodegradation.

TABLE 6.4 (Continued)
SUMMARY OF POTENTIAL REMEDIAL ACTIONS
SITE 23, FIRE TRAINING AREA
MACDILL AFB

Technology	Description	Comments
<u>SOILS (Continued)</u>		
Steam Stripping	An innovative, in-situ technology where bladed drilling equipment and steam are used to volatilize contaminants from soils. Vapors are collected at the surface, treated, and reinjected for closed-loop operation.	Steam will volatilize contaminants faster than air. Equipment provides soil mixing for more homogeneous treatment. Maximum removal efficiencies have not been demonstrated.
Capping	An impermeable barrier is placed over the soil surface to minimize the amount of water percolation through contaminated soils.	Tidal impacts on the groundwater might limit capping as an effective inflow control.
Solidification/ Encapsulation	Contaminated soils are incorporated in a solid matrix (in place) to reduce contaminant mobility and leachate generation.	Most economical for small waste quantities. The technology is developmental for organic contaminated soils.
<u>GROUNDWATER</u>		
Groundwater Recovery	Pumping from a well point system and/or trenches to withdraw contaminated groundwater.	A demonstrated technique for groundwater removal. Aquifer characteristics must be determined for design.
Activated Carbon	Groundwater removed by pumping is passed through a column where organic contaminants absorb to the carbon due to physical/chemical forces.	An applicable method for removing organic compounds from water.

TABLE 6.4 (Continued)
SUMMARY OF POTENTIAL REMEDIAL ACTIONS
SITE 23, FIRE TRAINING AREA
MACDILL AF3

Technology	Description	Comments
<u>GROUNDWATER (Continued)</u>		
Air Stripping	Removes volatile organics from an aqueous stream. If necessary, dissolved gases transferred to the air stream can be treated by activated carbon or thermal oxidation.	A demonstrated technology for removing organic contaminants from water.
Biodegradation	Biological treatment technique where bacteria utilize supplied oxygen to oxidize organics to CO ₂ .	Microorganisms have been acclimated to treat similar types of contaminants in water.
Off-Site Treatment at a POTW	Discharge to a Publically-Owned Treatment Work (POTW) wastewater collection and treatment system.	An application would be evaluated to determine the acceptability of withdrawn groundwater. The time to pump and treat groundwater before federal/state standards are met is not known.
Impermeable Barriers	Underground barriers used to physically divert groundwater flow away from an area or to contain a contaminant plume.	The barrier must be tied into a relatively shallow impermeable base layer. Tidal fluctuations may create O&M problems.
Subsurface Trenches	A trench is excavated, backfilled with highly permeable material, and usually lined to prevent plugging.	Requires continuous monitoring and may be used in conjunction with groundwater pumping, but well points are likely to be more easily operated in the fire training areas.

APPENDIX A
REFERENCES

APPENDIX A

REFERENCES

- American Petroleum Institute, 1986. "The Migration of Petroleum Products in Soil and Ground Water: Principles and Countermeasures," API Publication No. 4149.
- Benson, R. C., Glaccum, R. A., and Noel, M. R., 1982. "Geophysical Techniques for Sensing Buried Wastes and Waste Migration," U.S. Environmental Protection Agency, Las Vegas, Nevada.
- Bison, 1975. Bison Instruction Manual, Bison Instruments, Earth Resistivity Measurements: Bison Instruments, Inc., Minneapolis, Minnesota, 1975.
- Breiner, S., 1973. "Applications Manual for Portable Magnetometers," Geometrics, Sunnyvale, California.
- Carrington, T. J. and Watson, D. A., 1981. "Preliminary Evaluation of an Alternative Electrode Array for Use in Shallow-Subsurface Electrical Resistivity Studies," in Groundwater, Vol. 10, No. 1.
- CH2M-Hill, 1981. Installation Restoration Program Records Search for MacDill Air Force Base, Florida, AFESC, Tyndall AFB, Florida.
- Copper, H. H., Jr., Kohout, F. A., Henry, H. R. and Glover, R. E., 1964. Sea Water in Coastal Aquifers, U.S. Geological Survey WSP 1613-C.
- Driscoll, F. G., 1986. Groundwater and Wells, 2nd ed., Johnson Division, Minnesota.

- Fernald, E. A. and Patton, D. J., eds., 1984. Water Resources Atlas of Florida, Florida State University.
- Ferrris, J. G. and others, 1962. Theory of Aquifer Tests: U.S. Geological Survey Water-Supply Paper 1536-E.
- Freeze, R. A. and Cherry, J. A., 1979. Groundwater, Prentice-Hall, Inc., New Jersey.
- Geonics, 1984. Operating Manual for EM31-D Non-Contacting Terrain Conductivity Meter: Geonics Limited, Mississauga, Ontario, Canada.
- Hem, J. D., 1985. Study and Interpretation of the Chemical Characteristics of Natural Water, U.S. Geological Survey WSP 2254 (3rd ed.).
- Hingston, F. J., Posner, A. M., and Quirk, J. P., 1968. Adsorption of Selenite by Goethite, in Adsorption from Aqueous Solution, American Chemical Society - Advances in Chemistry Series No. 79.
- Kirkner, R. A. and Associates, Inc. 1986. Phase IV-A Investigation of Site A, MacDill Air Force Base, Florida.
- Krauskopf, K. B., 19789. Introduction to Geochemistry, 2nd ed., McGraw-Hill, p. 617.
- Lyman, W. J., Reehl, W. F., and Rosenblatt, D. H., 1982. Handbook of Chemical Property Estimation Methods - Environmental Behaviour of Organic Compounds, MacGraw-Hill, New York.
- Miller, J. A., 1986. "Hydrogeologic Framework of the Floridan Aquifer System in Florida and in Parts of Georgia, Alabama, and South Carolina," U.S. Geological Survey, Professional Paper 1403-F, Washington, D.C.

National Academy of Sciences - National Academy of Engineering, 1973.
Water Quality Criteria - 1972, (EPA Document R3.73.033) Washington,
D.C.

Ryan, J. D., Calder, F. D., Burney, L. C, and Windom, H. L., 1986.
Environmental Chemistry of Florida Estuaries: Deepwater Ports
Maintenance Dredging Study, Florida Department of Environmental
Regulation, Technical Report #1: Port of Miami and Miami River.

Ryder, P. D., 1985. "Hydrology of the Floridan Aquifer System in
West-Central Florida," U.S. Geological Survey, Professional Paper
1403-F, Washington, D.C.

Steinkampf, W. C., 1982. Origins and Distribution of Saline Ground
Waters in the Floridan Aquifer in Coastal Southwest Florida, U.S.
Geological Survey, WR1 82-4052.

U.S. Environmental Protection Agency, 1975. "Gas and Leachate from Land
Disposal of Municipal Solid Waste," Municipal Environmental
Research Laboratory, Cincinnati, Ohio.

U.S. Environmental Protection Agency, 1980. "Water Quality Criteria
Documents; Availability," Federal Register, Vol. 45, No. 231, pp.
79318-79379.

U.S. Environmental Protection Agency, 1984a. "Inductively Coupled
Plasma-Atomic Emission Spectrometer Method for Trace Element
Analysis of Water and Wastes," Federal Register, Vol. 49, No. 209,
October 26.

U.S. Environmental Protection Agency, 1984b. "Methods for Organic
Chemical Analysis of Municipal and Industrial Wastewater," Federal
Register, Vol. 49, No. 209, October 26.

U.S. Environmental Protection Agency, 1984c. "Test Methods for
Evaluating Solid Waste, Physical/Chemical Methods," SW-846, 2nd
ed.

U.S. Environmental Protection Agency, 1985. Methods of Analysis for Chlorinated Dibenzo P - Dioxins and Dibenzofurans, - 40 CFR 261, Appendix X.

Versar, 1979. Water Related Environmental Fate of 129 Priority Pollutants, Volumes I and II, U.S. EPA Publication 440/4-79-029 (NTIS Document NO. PB80-2043733).

Vershueren, K., 1983. Handbook of Environmental Data on Organic Chemicals, Van Nostrand Reinhold, New York.

Vik, Norman, 1987. Personal communication in December 1987. Hillsborough County Health Department, Engineering Section.

Water and Air Research, Inc., 1984. Installation Restoration Program Phase II - Confirmation/Quantification Stage I, Final Report for MacDill AFB, Florida, Tactical Air Command, Langley AFB, Virginia.

Wenner, Frank, 1916. "A Method of Measuring Earth Resistivity" in U.S. Bureau of Standards Bulletin, V. 12, P.469-478.

APPENDIX B
GLOSSARY OF TERMINOLOGY AND ABBREVIATIONS

APPENDIX B
GLOSSARY OF TERMINOLOGY AND ABBREVIATIONS

DEFINITIONS AND NOMENCLATURE

AF: Air Force (U.S. Air Force).

AFFF: Aqueous Film Forming Foam.

AFR: Air Force Range.

ALLUVIUM: Unconsolidated terrestrial sediment composed of sorted or unsorted sand, gravel, and clay that had been deposited by water.

AQUIFER: A geologic formation, or group of formations, that contains sufficient saturated permeable material to yield economically significant quantities of groundwater to wells and springs.

AROMATICS: Organic chemical compounds having a stable six-carbon ring as their basic structure, such as benzene, toluene, and xylenes.

ARTESIAN: A condition of confined aquifers in which water levels in wells rise above the top of the aquifer.

BEDROCK: Any solid rock in place; may be exposed at the surface of the earth or overlain by unconsolidated materials.

BENTONITE: A clay material, because of its ability to absorb water and swell, is commonly used for sealing around wells and in drilling muds.

CARBONATE ROCKS: A rock consisting chiefly of carbonate minerals, such as limestone and dolomite.

CONFINED AQUIFER: An aquifer bounded by impermeable strata or geologic units of distinctly lower permeability than that of the aquifer itself.

CONFINING STRATA: A strata of impermeable or distinctly less permeable material stratigraphically adjacent to one or more aquifers.

CONTAMINANT: As defined by section 104(a)(2) of CERCLA, shall include, but not be limited to, any element, substance, compound, or mixture, including disease causing agents, which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction) or physical deformation, in such organisms or their offspring.

DARCY'S LAW: An equation describing the flow of fluids in porous media based on the assumption that the flow is laminar and that inertia can be neglected.

DOD: Department of Defense.

DOWNGRADIENT: A direction that is hydraulically down slope. The down-gradient direction can be determined through a potentiometric survey or through the evaluation of existing water level elevations referenced to a common datum (mean sea level).

DRAWDOWN: The difference between the static water level and the water level in a well that is pumped.

dw: Dry weight.

ELECTRICAL RESISTIVITY SURVEY: A surface geophysical survey that indicates the electrical resistance of the earth to conductance of an induced electrical current. Results can be used to assess subsurface features such as the continuity of geologic conditions and the depth and extent of subsurface saturation.

EVAPOTRANSPIRATION: Evaporation from the ground surface and transpiration through vegetation.

FAULT: A fracture or fracture zone in the earth's crust along which there has been relative displacement.

FRACTURES: A break, rupture, or crack in rock. Can be the result of joints, faults, folding or any other movement in the rock itself.

GC: Gas chromatograph, an analytical laboratory instrument used for the quantitation and identification of organic compounds.

GC/MS: Gas chromatograph/mass spectrophotometer, an analytical laboratory instrument used for the quantitation and identification of organic compounds.

GROUNDWATER: All subsurface water, especially that part in the zone of saturation.

HALOGEN: Refers to any one of a group of chemical elements including fluorine, chlorine, bromine, and iodine.

HALOGENATED ORGANIC: Refers to any organic compound that contains one or more halogens as a substituent group.

HNU METER: An instrument that detects and quantifies organic vapor.

HYDRAULIC CONDUCTIVITY: Rate of flow of water in gpd through a cross-section of one square foot under a unit hydraulic gradient (gpd/ft²).

HYDRAULIC GRADIENT: Rate of change of pressure head per unit of distance of flow at a given point and in a given direction.

HYDRAULIC HEAD: Energy contained in a water mass, produced by elevation, pressure and velocity.

HYDROCARBONS: Organic chemical compounds composed of hydrogen and carbon atoms. Hydrocarbons may be straight chain, cyclic, branched chain, aromatic, or polycyclic, depending upon arrangement of carbon atoms. Halogenated hydrocarbons are hydrocarbons in which one or more hydrogen atoms has been replaced by halogen atoms.

ICPES: Inductively Coupled Plasma Emission Spectroscopy, an instrumental analytical method for quantitation of metal elements.

INFILTRATION: The movement of water through land surface into the ground.

IRP: INSTALLATION RESTORATION PROGRAM. Program instituted by the Department of Defense to assure compliance with hazardous waste regulations.

JP-4: Jet propulsion fuel number four (contains kerosene and gasoline fractions, used in most military jet aircraft).

LEACHING: The process by which soluble materials in soils or a landfill dissolve in water. The resulting leachate may percolate down into lower layers.

LITHOLOGY: The physical characteristics of a rock.

MAGNETIC SURVEY: A surface geophysical survey that indicates the total magnetic field intensity of the earth from a given site. Results can be used to locate subsurface features such as buried metallic objects and buried waste areas.

MIGRATION (CONTAMINANT): The movement of contaminants, through soil, water or air.

MSL: Mean sea level.

NET PRECIPITATION: Mean annual precipitation minus mean annual evapotranspiration.

OEHL: Occupational and Environmental Health Laboratory.

ORGANIC: Refers to chemical compounds having carbon atoms as their main skeletal structure. Most organic chemicals are created by living organisms or from their remains (such as fossil fuels) and occur naturally in the environment; other organic chemicals are man-made.

PERMEABILITY: A measure of the relative ease of fluid flow through a porous medium.

PESTICIDE: A chemical agent used to destroy pests, includes specialty groups known as herbicides, fungicides, insecticides, rodenticides, etc.

pH: A measure of the acidic or alkaline nature of aqueous solutions, specifically the negative logarithm of the hydrogen ion concentration.

PIEZOMETRIC SURFACE: The static level of the water in an aquifer; the surface to which water in an aquifer will rise under its full head.

POROSITY: The percentage of the total volume of a rock that is pore space (not occupied by mineral).

PRECIPITATION: Rainfall and snowfall.

QA/QC: Quality assurance and quality control.

RCRA: Resource Conservation and Recovery Act.

RECEPTORS: Individuals or groups of organisms or resources that are potentially affected by a contamination source.

RECHARGE AREA: The part of an aquifer that receives water by infiltration of surface water, precipitation, or an overlying aquifer. Recharge areas may be natural or manmade.

RECHARGE: The addition of water to the zone of saturation by natural or artificial processes.

SAC: Strategic Air Command.

SATURATED ZONE: That part of the earth's crust in which all voids are filled with water.

SEDIMENTARY ROCKS: Rocks formed by the consolidation of loose sediments that have accumulated in layers.

SPECIFIC CAPACITY: The rate of discharge of a water well per unit of drawdown, commonly expressed in gpm/ft or $m^3/day/m$.

STATIC WATER LEVEL: The level of water in a well that is not being affected by withdrawal of groundwater.

STRATUM: A single and distinct layer of homogeneous or gradational sedimentary material (consolidated rock or unconsolidated earth) of any thickness, visually separable from other layers above and below by a discrete change in the character of the material deposited or by a sharp physical break in deposition, or by both.

TOC: Total Organic Carbon.

TOX: Total Organic Halides.

TRANSMISSIVITY: A measure of an aquifer's capability to yield water; the rate at which water is transmitted through a unit width of aquifer under a unit hydraulic gradient.

TREMIE PIPE: A small-diameter pipe inserted into the well annulus, through which well construction materials are introduced.

UNCONFINED AQUIFER: An aquifer in which the water table forms the upper boundary.

UNSATURATED ZONE: (Vadose Zone or Zone of Aeration) - A subsurface zone containing water under pressure less than that of the atmosphere, including water held by capillary forces and containing air or gases generally under atmospheric pressure. This zone is limited by the land surface above and by the water table below.

UPGRADIENT: A direction that is hydraulically up slope.

USAF: United States Air Force.

VUGGY: Having numerous cavities or openings in a rock.

WATER TABLE: Surface of a body of unconfined groundwater at which the pressure is equal to that of the atmosphere.

UNITS OF MEASURE

g - grams

gpd - gallons per day

gpm - gallons per minute

mg/L - milligrams per liter

ug/g - micrograms per gram

ug/L - micrograms per liter

mg/kg - milligrams per kilogram

ug/kg - micrograms per kilogram

APPENDIX C
PROJECT TEAM BIOGRAPHIES

Biographical Data

DUANE R. BOLINE
Analytical Chemist

Experience Summary

Extensive experience in Analytical Chemistry. Over 20 years of experience in consulting environmental laboratory management, organics and inorganic analyses, and academic research. Knowledgeable of EPA analytical methods, protocols and quality assurance/quality control requirements. Responsible for coordination of chemical analyses in support of engineering projects.

Experience Record

1986-Present Engineering-Science, Atlanta, Georgia, Technical Manager, Laboratory Services. Dr. Boline is a member of the Engineering Direction Staff. This group of senior engineers and scientists provides technical assistance and direction for projects conducted by all ES offices. Responsibilities include quality assurance, development and implementation of training procedures for laboratory personnel, business development, consultation and project assistance.

1984-1986 Engineering-Science, Atlanta, Georgia, Director of Laboratory Service/Manager, Special Projects. Management of chemical analysis laboratory providing support to engineering-services. Major projects require analysis of samples from hazardous waste sites involved in remedial action assessment. In addition to laboratory management, technical support is provided to the engineering staff for proposal and report preparation.

Dr. Boline has directed the activities of analytical chemistry laboratories providing both organic and inorganic analyses. These laboratories use EPA recommended procedures for analyzing samples of air, water and solids. The methods utilized include gas chromatography/mass spectrometry, gas chromatography, high performance liquid chromatography, ion chromatography, atomic absorption spectrometry,

DUANE R. BOLINE
Analytical Chemist
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inductively coupled plasma emission spectroscopy, molecular absorption spectroscopy (U.V./Vis and I.R.) colorimetry, potentiometry and miscellaneous wet chemical test methods. Dr. Boline has provided the technical expertise for selection and proper execution of these various techniques to obtain the information required for each project.

Dr. Boline has written or participated in the writing of over 50 detailed General Work Plans for the EPA, other governmental agencies and commercial clients. His participation in Work Plan preparation has included selection of test parameters and applicable analysis methods, quality assurance and quality control protocols, health and safety factors, scheduling and estimated costs. Recently Dr. Boline participated in the preparation of eight Site-Specific test plans and Quality Assurance Project Plans. These Site-Specific plans provide the client and the project team members with a detailed description of the sampling and analysis procedures to be used during the investigation.

One of Dr. Boline's primary responsibilities is the review and evaluation of analytical methods proposed for specific projects in work plans prepared by ES personnel. He works closely with project managers and task leaders to ensure the analyses recommended will provide the desired data with the precision and accuracy required. His experience and familiarity with EPA test procedures has enabled ES to utilize screening procedures and multielement analysis methods to provide pertinent information to clients and achieve significant cost reductions.

Dr. Boline participates in the analysis of the overall program objectives in order to understand the specific information desired. He can therefore recommend specific procedures and QA/QC protocols to ensure the acquisition of pertinent data backed with adequate documentation. During the past year he has reviewed specific test requests for four military base phase II waste site investigations, and three EPA designated hazardous waste site investigations.

Data obtained by chemical analyses for use in regulatory enforcement actions, compliance evaluation or development and validation of methods to be used for these purposes must be technically valid and properly documented. Dr. Boline has reviewed data from previous studies at hazardous waste sites for two

DUANE R. BOLINE
Analytical Chemist
Page 3

commercial clients in the past year. His recommendations have been utilized to ensure subsequent testing would provide adequate data to support, repete or further define the previous test results. He has recently completed a review of test results from a previous study to develop methods for determining inorganic ions and radicals in a caustic scrubber brine used to minimize inorganic oxide emissions from a military incinerator. His recommendations enabled ES chemists to develop and validate modified analysis methods which provide the required accuracy and precision specified by the client.

1980-1984

Radian Corporation, Director of Analytical Services. Served as chemical analysis task leader and project manager for Hazardous Materials Laboratory Operations. Responsible for management of one of four profit centers within the company. Provided the marketing, technical, financial, and personnel management for the Analytical Services Laboratories.

Provided analytical support and technical consultation to clients in the chemical, petrochemical, wood and paper, electronics, synfuels, and other related fields.

Had responsibility for proposal preparation and project management for RCRA, NPDES, and other related projects. Obtained EPA Contract Laboratory Program projects for both organic and inorganic chemical analysis.

1968-1980

Assistant Professor; Associate Professor of Chemistry. Taught undergraduate and graduate analytical chemistry courses in addition to maintaining an active Master's Degree research group. Major research interests were trace metal analysis by atomic absorption spectroscopy, the enhancement of sensitivity obtained in flame atomic absorption by the use of organic solvents, and environmental chemistry.

This work included an investigation of the trace metal content of metalloenzymes separated by liquid chromatography by use of graphite furnace atomic absorption spectroscopy. The activity of the purified enzymes was investigated after removal or complexation of the metal and compared to the activity of the normal enzyme.

DUANE R. BOLINE
Analytical Chemist
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1962-1968 Kansas Public Schools, Science Teacher and Basket-
ball Coach.

Education

B.S.E., Physical Science, Emporia State University, 1962
M.S., Chemistry, Emporia State University 1965
Ph.D., Analytical Chemistry, Kansas State University, 1975

Professional Affiliations

American Chemical Society
Society for Applied Spectroscopy

Publications

Boline, Duane R., L. H. Keith and D. B. Walters, "Management of a Chemical Repository for Chemicals Used in Coded Toxicity Testing," Chapter 17, pp. 213 - 220 in Chemistry For Toxicity Testing, C. W. Jameson, D. B. Walters, editors, Butterworth Publishers, 1983.

Boline, Duane R., "Some Speciation and Mechanistic Aspects of Trace Metals in Biological Systems," Chapter 44 in Environmental Health Chemistry--Chemistry of Environmental Agents as Potential Hazards, James McKinney, editor, Ann Arbor Press, Ann Arbor, MI, 1980.

Boline, Duane R. and W. G. Schrenk, "Atomic Absorption Spectroscopy of Copper and Iron in Plant Material," J.A.O.A.C., 60, 1170-1174, 1977.

Boline, Duane R. and W. G. Schrenk, "A Method for Determination of Cadmium in Plant Materials by Atomic Absorption Spectroscopy," J. Appl. Spectros., 30, 607-610, 1976.

Papers and Presentations

Boline, Duane R., L. H. Keith, and D. B. Walters, "Inventory Management and Data Storage for Chemicals Used in Coded Toxicity Testing," American Chemical Society Meeting, Las Vegas, NV, 1982.

Boline, Duane R., L. H. Keith, and D. B. Walters, "A Computerized Data Management System for a Hazardous Materials Laboratory," American Chemical Society Meeting, New York, NY, 1981.

Daub, Robert and Duane R. Boline, "A Comparison of the Growth Rate and Chlorophyll Production of *Eglenia Gradilis* as a Function of Copper Content in the Organism," Kansas Academy of Science Meeting, Fort Hays, KS, 1980.

DUANE R. BOLINE
Analytical Chemist
Page 5

Parli, Joseph and Duane R. Boline, "A Method for the Determination of Boron by Electrically Heated Tantalum Ribbon Atomic Absorption Spectroscopy," Midwest Regional American Chemical Society Meeting, St. Louis, MO, 1979.

Hiebert, Greg and Duane R. Boline, "A Comparison of the Sensitivity Obtained for the Determination of Copper by Atomic Absorption Spectroscopy, as a Function of Physical Properties of Non-Aqueous Solvents," Kansas Academy of Science, Wichita, KS, 1979.

Parli, Joseph and Duane R. Boline, "A Method for the Determination of Copper in Plant Material by Atomic Absorption of Spectroscopy Using an Acidic Methanol Solvent," Midwest Regional American Chemical Society Meeting, Fayetteville, AR, 1978.

Boline, Duane R. and W. G. Schrenk, "A Method for the Determination of Copper and Iron in Plant Material by Atomic Absorption Spectroscopy," National AOAC Meeting, Washington, DC (1976) and Rocky Mountain Conference on Applied Spectroscopy, Denver, CO, 1975.

Boline, Duane R. and W. G. Schrenk, "A Method for the Determination of Cadmium by Atomic Absorption Spectroscopy," Rocky Mountain Conference on Applied Spectroscopy, Denver, CO, 1974.

Biographical Data

WALKER J. DUNCAN

Hydrogeologist

Experience Summary

Extensive experience in management, planning, and implementation of field programs at hazardous waste and industrial sites. Design and implementation of monitoring wells; soil, surface water, and groundwater sampling programs; hydrogeological and geological studies for contamination assessments and remedial design at hazardous waste sites.

Experience Record

1985-Date Engineering-Science, Atlanta, Georgia. Geologist/Hydrogeologist. Responsible for collection and assessment of data for contamination assessment and remedial design at hazardous waste sites.

Project responsibilities have included supervision of field data collection and interpretation for the U. S. Air Force's Installation Restoration Program for Edwards AFB, March AFB, and AF Plant 42, in California. These programs are Phase II and Phase IV work and have included soil sampling, monitoring well layout and installation, geophysical log interpretation, aquifer tests and data interpretation, groundwater sampling, plume delineation, and report preparation. Project manager for the U.S. Air Force's IRP Phase II at MacDill AFB in Tampa, Florida.

Other project responsibilities have included field sampling supervision at a NPL landfill in New Jersey; regulatory review of a NPL landfill in Tampa, Florida; field supervision of well installation and aquifer testing for industrial clients in Tennessee and South Carolina.

1980-1985 WAPORA, Inc., Environmental Consultants, Norcross, Georgia. Geologist. Responsibilities included preparation of groundwater, soils, and geology sections for EIS's and EAs; design and review of groundwater monitoring plans; preparation of RCRA Part B permits;

WALTER J. DUNCAN
Hydrogeologist
Page 2

groundwater assessments including well installation; surface water and groundwater monitoring plan design and implementation.

- 1977-1980 Atlanta Testing and Engineering Company, Geotechnical Engineers, Norcross, Georgia. Staff Geologist. Responsibilities included boring layout, drilling supervision, logging of drill holes, seismic investigations, pump testing, packer testing of boreholes, investigations for land applications of industrial waste, geotechnical investigations at small dam sites, investigations at large Georgia Power reservoir sites.
- 1976-1977 Howard Schoenike and Associates, Consulting Geologists, Houston, Texas. Mine Geologist at a surface coal mine in northwest Georgia. Responsible for site and regional coal exploration.
- 1975-1976 Geoconsultants, Inc., Geotechnical Engineers, Atlanta, Georgia. Driller and Soils Technician for small consulting firm.
- 1973-1975 Soil Systems, Inc., Geotechnical Engineers, Marietta, Georgia. Driller and Soils Technician.

Education

B.S. Geology, Georgia State University, Atlanta, 1976.

Professional Affiliations

National Water Well Association
Geological Society of America

Biographical Data

EDWARD L. GRUNWALD
Health and Safety Manager

Experience Summary

Extensive experience in the development and management of safety and quality assurance programs. Responsible for health and safety activities and quality assurance programs for hazardous waste investigations.

Experience Record

1985-Date Engineering-Science. Corporate Health and Safety Manager. Responsible for the development and implementation of Engineering-Science's health and safety program. Additional responsibilities include the development of quality assurance plans and standard operating procedures for hazardous waste site investigations and remedial projects.

1983-1985 NUS Corporation. Regional Safety Manager, Quality Assurance Manager. Worked as a member of a multidisciplinary field investigation team (FIT) under contract with the U.S. Environmental Protection Agency for the investigation of uncontrolled hazardous waste sites. Duties as a safety officer included the training of field personnel in instrumentation and site safety considerations, determination of the type of respiratory and percutaneous protection needed for each field activity, development of safety procedures and guidelines for the office, and scheduling of personnel for medical examinations. Also responsible for all the Quality Assurance/Control activities in the office. These duties included the development of Quality Assurance/Control Guidelines and the auditing of projects to insure compliance with EPA's, NEIC's, and NUS's Quality Assurance Control Procedures. Instructed U.S. EPA Region IV FIT Office personnel in the philosophy and procedures of the Quality Assurance Program.

As a toxicologist, authored the Endangerment Assessment Sections to four RI/FS studies. Experience included environmental fate modeling and carcinogenic and noncarcinogenic risk assessment.

Project Manager for eight superfund sites.

EDWARD L. GRUNWALD
Health and Safety Manager
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- 1982 Johns Hopkins Hospital. Research Programmer. Responsibilities included computer management and the processing of research data.
- 1980-1982 University of Massachusetts. Interned as a Laboratory Health Manager. Duties were to inspect the laboratories on campus and make suggestions as to safety improvements.
- 1980-1981 University of Massachusetts. Teaching Assistant for courses in Microbiology and Industrial Hygiene for the Public Health Department.
- 1978-1979 Johns Hopkins Hospital. Research Assistant in the Cardiology Department. Research focus was on the enzyme creatine kinase and the role it has in ischemic heart disease.

Education

B.S., Bacteriology, 1978, Ohio Wesleyan University
M.S., Public Health (Toxicology Specialization), 1982, University of Massachusetts

Professional Affiliations

Society of Environmental Toxicology and Chemistry

Honors and Awards

National Science Foundation Research Participation Program Winner

Publications

"Ozone-Induced Decrease of Erythrocyte Survival in Adult Rabbits," Advances in Modern Environmental Toxicology, Volume 5, 1982.

"Protection By Ascorbate Against Acetylphenylhydrazine Induced Heinz Body Formation in Normal Human and Sheep Erythrocytes," The Journal of Environmental Science and Health, Volume 6, pp. 897-902, 1982.

Papers and Presentations

"The Salmonella/Mammalian-Microsome Mutagenicity Test." Presented before the Honor Society at Ohio Wesleyan University, June 1978.

"Ozone-Induced Decrease of Erythrocyte Survival in Adult Rabbits," presented at the U.S. EPA-sponsored International Symposium on Ozone Toxicology, Pinehurst, North Carolina, March, 1982.

Biographical Data

MARK A. GUTHRIE, P.E.
Environmental Engineer

Experience Summary

Wide variety of technical experience in hazardous and industrial waste treatment processes and hazardous waste site investigations. Experience includes extensive background in field sampling, laboratory analyses, treatability testing, and process engineering, with emphasis on the identification, development, and evaluation of waste treatment and site remediation alternatives.

Experience Record

1985-Date

Engineering-Science, Atlanta - Hazardous Wastes Group Project Manager. Involved in a variety of activities related to hazardous waste management, including remedial investigation and feasibility studies (RI/FS), and remedial design and construction at uncontrolled hazardous waste sites. Representative project experience is described below.

Conducted IRP Phase II - Confirmation/Quantification investigations at USAF Plant 42 (Palmdale, California) and MacDill AFB, Florida under the Air Force Installation Restoration Program (IRP). These surveys involved the collection of field data on past waste disposal and spill sites to determine the presence extent of environmental contamination, and to recommend appropriate remedial actions and long-term monitoring. Activities included soil boring and sampling, monitoring well installation, ground & surface water sampling, chemical analysis of environmental samples, geophysical surveys, and public health and environmental risk assessments.

Performed conceptual design of ground-water recovery, treatment and disposal systems for source control and remediation at a former waste oil reclamation facility included on the National Priorities List (NPL). The project was conducted for the Florida Department of Environmental Regulation. Activities included contamination assessment, ground-water flow and recovery system testing, treatability testing, and alternatives evaluation with estimates of capital and operating costs for the proposed systems.

Conducted treatability testing and conceptual design of an on-site wastewater treatment system for remedial

MARK A. GUTHRIE, P.E.
Environmental Engineer
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action at an abandoned hazardous waste treatment site. The system consisted of oil separation, metals precipitation, solids removal, multimedia filtration, and activated carbon adsorption. Specific contaminants included waste oils, PCB, phenol, and heavy metals.

1981-1985

Engineering-Science, Atlanta - Industrial Wastes Group Project Manager and Project Engineer. Conducted field studies, preliminary engineering, and process design of treatment and disposal technologies for industrial wastes. Activities included waste characterization studies, treatability testing, process sizing and design criteria development, technical and economic alternatives evaluations, process design, performance and capacity evaluations of existing systems, and operations assistance for industrial waste treatment facilities. Extensive experience in biological systems and anaerobic treatment facilities.

Specific industrial experience includes: synthetic fibers and intermediates, cellulose acetate, silicones, herbicides and pesticides, synthetic pharmaceuticals, industrial enzymes, citric acid, phenolic plastic resins, ABS plastics, textile dyes, and electronics manufacturing.

1978-1980

Purdue University, West Lafayette - Graduate Research Assistant. Developed and evaluated an experimental protocol for determining the biodegradability and fate of specific organic priority pollutants during the anaerobic digestion of wastewater sludges. Activities included bioassays to determine toxicity of specific compounds, enrichment techniques for acclimation of methanogenic cultures, bench-scale anaerobic digester operation, experiments to quantify sorption and volatilization of test compounds, determination of extent of biodegradation, and analysis of test compounds by gas-liquid chromatography. Dimethyl phthalate and pentachlorophenol were used for protocol evaluation.

Education

B.S.E. in Civil Engineering, 1978, Duke University
M.S.C.E. in Environmental Engineering, 1983, Purdue University

Professional Affiliations

Registered Professional Engineer (Georgia)
American Chemical Society
American Society for Microbiology
Association of Ground Water Scientists and Engineers (NWWA)
International Association for Water Pollution Research and Control
Water Pollution Control Federation

MARK A. GUTHRIE, P.E.
Environmental Engineer
Page 3

Publications

"Fate of Pentachlorophenol in Anaerobic Digestion", M. A. Guthrie, E. J. Kirsch, R. F. Wukasz, and C. P. L. Grady, Jr., Proceeding of the 1981 Conference on Environmental Engineering, A.S.C.E., 1981.

"Experimental Strategy for Evaluating the Fate of Priority Pollutants in Wastewater Treatment Systems", E. J. Kirsch, C. P. L. Grady, Jr., M. A. Guthrie, L. P. Moos, and R. F. Wukasz, Proceedings of the Fifth International Symposium on Biodeterioration, Eds. T. A. Oxley and S. Barry, Pub. John Wiley and Sons Ltd., 1983.

"Development and Evaluation of an Experimental Protocol for Determining the Biodegradability and Fate of Specific Organic Chemicals During Anaerobic Digestion: Dimethylphthalate and Pentachlorophenol", M. A. Guthrie, M.S.C.E. thesis presented to Purdue University, 1983.

"Pentachlorophenol Biodegradation II - Anaerobic", M. A. Guthrie, E. J. Kirsch, R. F. Wukasz, and C. P. L. Grady, Jr., Water Research, Volume 18, Number 4, 1984.

"Fermentation Industry Wastewater Treatment - Aerobic vs Anaerobic", M. A. Guthrie, M. R. Hockenbury, P. A. Turpin, J. I. Cooper, V. R. Worrell, Proceedings of the Industrial Wastes Symposia, 57th Annual Water Pollution Control Federation Conference, 1984.

"Treatment and Disposal Technologies for Liquid Hazardous Wastes as Alternatives to Subsurface Injection", G. C. Patrick, M. A. Guthrie, and T. N. Sargent, Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes, sponsored by Underground Injection Practices Council, National Water Well Association, and U.S. Environmental Protection Agency, 1986.

"Economic Impacts of Alternative Technologies for Treatment and Disposal of Liquid Hazardous Wastes", M. A. Guthrie, G. C. Patrick, and T. N. Sargent, Proceedings of the International Symposium on Subsurface Injection of Liquid Wastes, sponsored by Underground Injection Practices Council, National Water Well Association, and U.S. Environmental Protection Agency, 1986.

Evaluation of Current Underground Injection of Hazardous Waste in Illinois, R. D. Brower, A. P. Visocky, I. G. Krapac, B. D. Hensel, G. R. Peyton, J. S. Nealon, and M. A. Guthrie, published by Illinois Department of Energy and Natural Resources, Hazardous Waste Research and Information Center, 1986.

"Study of Current Underground Injection Control Regulations and Practices in Illinois," A. P. Visocky, J. S. Nealon, R. D. Brower, I. G. Krapac, B. D. Mensel and M. A. Guthrie, Ground Water Monitoring Review, Volume 6, Number 3, 1986.

Biographical Data

ROBERT S. McLEOD, P.E.
Senior Hydrologist

Experience Summary

Mr. McLeod has more than 24 years of experience in ground water and surface water hydrology. He has served as project manager on studies related to developing ground water for industrial and municipal water supplies and on studies involving remedial investigations, feasibility studies and cleanup activities at hazardous waste facilities. He also has served as an expert witness in settlement negotiations involving the federal government, state government, local governmental agencies and industries.

Experience Record

1986-Date	Engineering-Science, Inc. <u>Senior Hydrologist and Manager, Earth Sciences Section.</u> Responsible for management of hydrogeologists and geologists involved in work related to surface and subsurface investigations at hazardous waste sites.
1985-1986	A TEC Associates, Inc., Marietta, Georgia. <u>Manager, Environmental Services Division.</u> Responsible for development and management of the Environmental Services Division of A TEC Associates in the southeast United States.
1982-1985	Engineering-Science, Inc. (Part-time). <u>Senior Hydrologist.</u> Project manager on several studies involving remedial investigations, feasibility studies and cleanup activities at hazardous waste facilities.
1982-1985	Robert S. McLeod and Associates, Inc., Marietta, Georgia. <u>Consulting Hydrologist</u> on studies relating to ground-water resources evaluation.
1980-1982	Law Engineering Testing Company, Atlanta, Georgia. <u>Senior Water Resources Engineer.</u> Directed the analysis and reporting of data on a 25-million dollar project for evaluating the feasibility of using salt domes in the Gulf Coast area for the storage of high-level nuclear wastes.
1964-1980	U.S. Geological Survey. WRD Division, Madison, Wisconsin. <u>Project Chief</u> (1970-1980). Conducted regional

ROBERT S. McLEOD, P.E.
Senior Hydrologist
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ground water studies involving evaluation of the occurrence, movement and availability of ground water. These studies included modeling ground-water flow and investigating ground water-surface water relationships.

Project Hydrologist (1964-1970). Participated in numerous studies to define the availability of surface and groundwater for industrial and municipal supply.

1962-1964 U.S. Army Corps of Engineers. Staff Engineer. Monitored dredging operations for harbor improvements and assisted resident engineer in managing rehabilitation work at a low-head dam.

Education

B.S., Civil Engineering, University of Illinois, 1962
M.S., Civil Engineering, University of Wisconsin, 1965
Full-time advanced graduate studies in hydrology and hydrogeology, University of Wisconsin, 1966-67, 1969-70

Professional Affiliations

Registered Professional Engineer, Georgia and Tennessee
Certified Ground Water Professional, Association of Ground Water Scientists and Engineers
Certified Professional Ground Water Hydrologist, American Institute of Hydrology
American Society of Civil Engineers
American Water Resources Association
National Water Well Association
National Society of Professional Engineers
American Institute of Hydrology

Publications

McLeod, R. S., 1973, Ground-water occurrence and movement related to aquifer system models: in Workshop Proceedings, Indiana Water Resources - Future Problems and Needs, Purdue University, May 10-11, 1973.

McLeod, R. S., 1975, A digital-computer model for estimating draw-downs in the sandstone aquifer system in Dane County, Wisconsin: Wisconsin Geological and Natural History Survey Information, Circ. 28, 91 p.

ROBERT S. McLEOD, P.E.
Senior Hydrologist
Page 3

McLeod, R. S., 1975, A digital-computer model for estimating hydrologic changes in the aquifer system in Dane County, Wisconsin: Wisconsin Geological and Natural History Information circ. 30, 40 p.

McLeod, R. S., 1978, Water level declines in the Madison area, Dane County, Wisconsin: U.S. Geological Survey open file report, 15 p.

McLeod, R. S., 1980, The effects of using ground water to maintain water levels of Cedar Lake, Wisconsin: U.S. Geological Survey Water Resources Investigation 80-23, 35 p.

McLeod, R. S., 1984, Evaluation of Superfund sites for control of leachate and contaminant migration: in proceedings, Conference and Management of Uncontrolled Hazardous Wastes Sites, (November 7-9, 1984), Hazardous Materials Control Research Institute.

Papers and Presentations

"Relation Between Ground Water Pumping and Streamflow in the Yahara River Watershed, Wisconsin," presented at the Madison Hydrology Club, November 1978.

"Ground-Water Modeling Techniques for Managing Aquifer Systems," presented at the University of Wisconsin Continuing Education Sanitary Engineering Institute, March 1979.

"Water Use Data Collection Program in Wisconsin," presented at the Midwest Ground Water Conference, November 1979.

"Ground Water Flow in the Vicinity of Richton and Cypress Creek Salt Domes, Perry County, Mississippi," presented at the Fifth Southeastern Ground Water Conference, November 1981.

Biographical Data

ERNEST J. SCHROEDER
Environmental Engineer

Experience Summary

Nine years of environmental engineering experience with Union Carbide working in research, engineering, construction and operations plus ten years of environmental consulting experience conducting industrial waste treatment and hazardous waste management projects. Very actively involved, during the last six (6) years, in remedial action projects at hazardous waste sites.

Experience Record

1976-Date Technical Director for Eastern Group Hazardous Waste Projects (1985 - Date). Responsible for technical review and direction of hazardous waste projects conducted by Engineering-Science Eastern Group.

Engineering-Science, Inc., Manager of Solid and Hazardous Waste Group in the Atlanta, Georgia office (1980-date). Responsible for the supervision of solid and hazardous waste project managers and project engineers and the management of solid and hazardous waste projects in the office. Project activities have included permit and regulatory assistance, environmental audits, waste management program development, delisting partitions, ground-water monitoring, landfill evaluations, landfill closure design, hazardous waste management, waste inventory, waste recovery/recycle evaluation, waste disposal alternative evaluation, transportation evaluation, and spill control and countermeasure planning, HRS evaluations, preparation of remedial investigations and feasibility studies, and design and construction supervision for hazardous waste site cleanup.

Project Manager for Phase I Installation Restoration Program projects for the U.S. Air Force, environmental audits (air, water and solid waste) at industrial facilities, contamination assessment and hazardous waste site cleanup projects conducted for industrial clients as part of consent degree agreements, and four Remedial Investigation/ Feasibility Studies projects.

ERNEST J. SCHROEDER
Environmental Engineer
Page 2

Engineering-Science, Inc., Manager of the Industrial Waste Group in the Atlanta, Georgia office (1978-1980). Responsible for the supervision of industrial waste project managers and project engineers and the management of industrial waste studies conducted in the office. Also directly involved in project management consulting with clients on environmental studies and environment assessment projects, e.g., project manager for several spill control and wastewater treatability projects and for a third-party EIS for a new phosphate mine in Florida.

Engineering-Science, Inc., Project Manager (1976-1978). Engineering and project management of various industrial wastewater and hazardous waste projects.

1967-1976

Union Carbide Corporation, Environmental Protection Project Engineer, Toronto, Ontario, Canada (1975-1976). Responsible for the environmental permitting and engineering design of waste treatment systems associated with a new refinery.

Union Carbide Corporation, Environmental Protection Department, Texas City, Texas (1969-1975). Project Engineer and Engineering Supervisor. Responsible for various aspects of plant pollution abatement programs, including preparation of state and federal permits for wastewater treatment activities, operations representative on \$8 million regional wastewater treatment project (process design, detailed design, construction and startup), and supervisor for operation of wastewater collection and treatment facilities.

Union Carbide Technical Center, Engineering Department, South Charleston, West Virginia (1967-1968). Project Engineer. Responsible for environmental protection engineering projects for various organic chemicals and plastics plants.

Education

B.S. in Civil Engineering, 1966, University of Arkansas
M.S. in Sanitary Engineering, 1967, University of Arkansas

Professional Affiliations

Registered Professional Engineer (Arkansas No. 3259, Georgia No. 10618, Texas No. 33556 and Louisiana No. 21685)
American Academy of Environmental Engineers (Diplomate)
Water Pollution Control Federation

ERNEST J. SCHROEDER
Environmental Engineer
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Honorary Affiliations

Chi Epsilon

Publications

"Activated Carbon Adsorption for Textile Wastewater Pollution Control," Symposium Proceedings: Textile Industry Technology, Williamsburg, Virginia, December 1978 (Coauthor A. W. Loven, Ph.D).

"Pilot Plant Evaluation of the 1974 BATEA Guidelines for the Textile Industry," Proceedings of 35th Industrial Waste Conference, Purdue University, Indiana, May 1980 (Coauthor W. A. Storey).

Papers and Presentations

"Filamentous Activated Sludge Treatment of Nitrogen Deficient Waste," Masters of Science Research Paper, University of Arkansas, Fayetteville, Arkansas, 1967.

"Summary Report of the BATEA Guidelines (1974) Study for the Textile Industry," presented to North Carolina Section of AWAA/WPCA, Pinehurst, North Carolina, November 1979.

"Industrial Solid Waste Management Program to Comply with RCRA," engineering short course presented at Auburn University, Alabama, October 1980.

"Technical and Economic Impact of RCRA on Industrial Solid Waste Management," presented to Florida Section of American Chemical Society, May 1981.

"Hazardous Waste Site Rating Systems," presented to Textile Wastewater Treatment and Air Pollution Control Conference, Hilton Head Island, South Carolina, January 1983 (Coauthor T. N. Sargent).

Biographical Data

SHARON A. SCHULTZ
Environmental Scientist

Experience Summary

Extensive environmental sampling experience during 6 years of professional practice. Considerable experience in surface geophysical surveys, soil boring programs and computerization of environmental data. Specialized experience in planning and execution of field sampling programs and in laboratory analytical techniques.

Experience Record

- | | |
|-----------|--|
| 1984-Date | Engineering-Science, Atlanta, Georgia. <u>Environmental Scientist</u> . Member of crew employing electrical resistivity, magnetometer and electromagnetics to investigate ground-water contamination at numerous hazardous waste disposal sites. Responsible for reduction of Geophysical field data using computerized data packages and interpretation of field data. Leader of field crew sampling ground-water monitoring wells, surface waters, bore holes and surface sediments. Additional responsibilities include Soil-Gas Monitoring, aquifer pump tests, solidification testing and report preparation. |
| 1984 | Applied Biology, Inc., Decatur, Georgia. <u>Chemist - Metals Analyst</u> . Responsible for managing and maintaining metals laboratory. Duties include sample preparation and sample analysis on Atomic Absorption Spectrophotometer. Responsible for implementing strict quality assurance program for metals analysis, ensuring proper handling procedures are carried out for hazardous materials. |
| 1983-1984 | Claude Terry & Associates, Inc., Atlanta, Georgia. <u>Environmental Scientists, Taxonomic Specialist, Environmental Assessment</u> . Responsible for sampling, identification and analysis of periphyton community on the state-wide Georgia Nonpoint Source Pollution Assessment Study. Maintained quality assurance program for study components. Other responsibilities included the review of terrestrial and aquatic protected species surveys and the development and application of environmental impact and assessment methodologies. |
| 1980-1983 | Applied Biology, Inc., Decatur Georgia. <u>Environmental Scientist, Quality Control Clerk, Plankton Taxonomist</u> . Performed extractions for use in the detection of |

SHARON A. SCHULTZ
Environmental Scientist
Page 2

herbicides and pesticides. Responsible for maintaining wet chemistry lab and performing all phases of sample analysis as outlined in Standard Methods. Maintained quality assurance files. Conducted in-house audit. Responsible for identification and counts of marine zooplankton samples. Experienced in the use of field equipment for physical and chemical measurements. Member of crew for vegetation study in a Florida power plant's cooling canals.

- 1980 Mangrove Planting Crew, Hutchinson Island, Florida. Growth Monitor, Planting Crew Member. Monitored tree growth, planted trees.
- 1979 Applied Biology, Inc., Jensen Beach, Florida. Marine Benthic Organism Taxonomist. Sorted and identified benthic macroinvertebrates.
- 1978 Florida Institute of Technology, Sediment Survey Team. Sediment Content Analysis Technician. Worked as soil surveyor.

Education

A.S. in Environmental Technology, 1980, Florida Institute of Technology

Biographical Data

CRAIG L. SPRINKLE
Senior Hydrogeologist

Experience Summary

Extensive experience in planning, executing and reporting on hydrogeologic studies spanning 13 years of professional practice. Responsible for design, conduct, and evaluation of studies utilizing surface-water, ground-water, bore-hole geophysical, and geochemical data from sites in six southeastern states.

Experience Record

1986-Present Engineering-Science. Senior Hydrogeologist. Responsible for evaluation and interpretation of geologic, hydrologic, and chemical data obtained from USAF IRP studies and other hazardous-waste site investigations.

1975-1986 U.S. Geological Survey-WRD. Staff Hydrologist (1985-1986). Responsible for developing techniques, instituting new programs, and conducting research in quantitative ground-water studies. Coordinator for EPA-USGS cooperation on ground-water protection, and USAF-USGS cooperation on IRP program. A principal author of Department of Interior rule on assessment of natural resource damages (CERCLA 301(c)).

Hydrologist (1975-1985). Responsible for conducting areal studies and writing interpretive reports dealing with water resources in parts of six southeastern states.

1973-1975 Tennessee Department of Public Health - Division of Solid Waste Management. Geologist. Responsible for site investigations of existing and potential sanitary and hazardous-waste landfills. Reports were basis for acceptance/certification of sites by State.

Education

B.A., Geology, 1970, Vanderbilt University
M.S., Geochemistry, 1973, Vanderbilt University
B.S., Civil Engineering, 1977, University of Tennessee

CRAIG L. SPRINKLE
Senior Hydrogeologist
Page 2

Professional Affiliations

Geological Society of America
American Geophysical Union
International Association of Hydrologists
Geochemical Society
National Water Well Association

Publications

"A study of factors controlling the chemical quality of water in Cartwright Creek Basin, Williamson County, Tennessee," Water Resources Research Center Report No. 42, University of Tennessee-Knoxville, 1974.

"Hydrogeochemistry in a carbonate basin-geomorphic and environmental implication," Water Resources Research Center Report No. 44, University of Tennessee-Knoxville, 1975.

"Leachate migration from a pesticide waste disposal site in Hardeman County, Tennessee," U.S. Geological Survey WRI 78-128, 1978.

"Sulfate concentration in water from the upper permeable zone of the Tertiary limestone aquifer system, southeastern United States," U.S. Geological Survey WRI 81-1101, 1982.

"Total hardness of water from the upper permeable zone of the Tertiary limestone aquifer system, southeastern United States," U.S. Geological Survey WRI 81-1102, 1982.

"Chloride concentration in water from the upper permeable zone of the Tertiary limestone aquifer system, southeastern United States," U.S. Geological Survey WRI 81-1103, 1982.

"Dissolved-solids concentration in water from the upper permeable zone of the Tertiary limestone aquifer system, southeastern United States," U.S. Geological Survey WRI 82-94, 1982.

"Summary of hydrologic testing in Tertiary limestone aquifer, Tenneco offshore exploratory well Atlantic OCS, lease block 427 (Jacksonville NH 17-5)," U.S. Geological Survey Water-Supply Paper 2180, 1982.

"Evaluation of ground-water quality data from Kentucky," U.S. Geological Survey WRI 83-210, 1983.

"Authigenic fluorite in dolomitic rocks of the Floridan aquifer," Geology, 1985.

"Geochemistry of the Floridan aquifer system in Florida and in parts of Georgia, South Carolina, and Alabama," U.S. Geological Survey Prof. Paper 1403-I, in press.

CRAIG L. SPRINKLE
Senior Hydrogeologist
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Papers and Presentations

"Downstream effects of strip mining on water quality in the New River Basin, Tennessee," presented at symposium on environment and mining research at University of Tennessee-Knoxville, 1978.

"Sampling for organic contaminants associated with the pesticide waste dump in Hardeman County, Tennessee," presented at American Geophysical Union fall meeting, 1979.

"Mapping water quality of the Tertiary limestone aquifer system, southeastern United States," presented at Geological Society of America annual meeting, 1980.

"Geochemistry of water from two wells in the Tertiary limestone aquifer system, Georgia and Florida," presented at Geological Society of America southeastern section meeting, 1982.

"Modeling mass transfer in the Tertiary limestone aquifer system, southeastern United States," presented at Geological Society of America southeastern section meeting, 1983.

Biographical Data

KENNETH J. STOCKWELL
Environmental Engineer

Experience Summary

Experience in planning, managing and conducting Hazardous Waste Remedial Investigations and Feasibility Studies. Direct responsibility for preparation of budgets and sampling and quality assurance plans as well as implementation of field investigations. Specific experience includes liaison with state and federal agencies during planning as well as administration and oversight of subcontracts. Project Manager for ongoing RI/FS efforts at two sites in the National Priority List, numerous other sites involving fuel and solvent contamination, and for construction oversight of a groundwater recovery and treatment system. Detailed experience in program management and specific project management of multiple task order contracts requiring consistency in planning, budgeting and reporting.

Experience Record

1985-Date Engineering-Science. Project Manager for a RI/FS on a hazardous waste site on the National Priorities List. Responsibilities included liaison between the Potentially Responsible Parties (PRPs), the USEPA and applicable state agencies during preparation of remedial investigation plans and implementation of the field study. Directly responsible for staffing, coordinating and conducting the field investigation and preparation of the remedial investigation report. Included in the site evaluation was a hydrogeologic site assessment and preparation of a public health risk assessment and contaminant transport evaluation. Media investigated included ground water, soils and surface water. The contaminants of concern were metals. Also directly responsible for the evaluation of alternatives for site remediation under the Feasibility Study. Tasks included selection and bench scale testing of treatment processes and engineering and cost evaluation of various alternatives under the requirements of CERCLA and SARA.

Project Manager for site investigations and remedial action plan development (feasibility studies) for fuel spill sites on two U.S. Air Force Bases. Responsibilities included preparation of plans and implementation of the field investigation. Data evaluation and evaluation of potentially applicable remedial alternatives will be conducted and a final remedial action plan or feasibility study prepared.

KENNETH J. STOCKWELL
Environmental Engineer
Page 2

Project Manager for construction oversight and start-up of a ground-water recovery and treatment system for the removal of jet fuel from an aquifer on a U.S. Air Force base. Project activities included oversight of the installation of sixteen recovery wells according to specifications prepared by Engineering-Science and preparation of an operations and maintenance manual for start-up and system operation.

Project Manager for a site investigation to assess levels of herbicide and pesticide contamination. Project included soil and surface water sampling and analysis. Future activities will include ground water assessment.

Project Manager for an ongoing RI/FS on a landfill on the National Priorities List. Specific responsibilities include design and implementation of the field investigation including preparation of sampling, quality assurance and health and safety plans. This project involves potential organic contamination of an aquifer.

Project Engineer responsible for field investigation activities at multiple disposal sites on an industrial manufacturing facility. Required detailed planning, scheduling, budgeting and oversight of a fast-track field investigation. Specific activities conducted included field sample collection of soils, sediments and surface and ground water as well as oversight of geophysical survey, soil boring and monitoring well installation activities. The primary contaminant was combustible elemental phosphorous.

Deputy Program Manager and Project Engineer responsible for administrative coordination and technical review for a major on-going hazardous waste site investigation contract. Responsibilities include contract administration, implementation and general oversight of multiple delivery orders. Specific activities include preparation of work plans, budgets, schedules and reports.

1983-1985

Applied Biology, Incorporated, Decatur, Georgia. Staff Environmental Engineer. Responsible for providing engineering evaluation in the preparation of NEPA related studies such as environmental impact statements and assessments.

Conducted administrative management and coordination of field activities for a major ground-water monitoring study in the barrier islands of North Carolina. Responsible for all aspects of field sampling and data

KENNETH J. STOCKWELL
Environmental Engineer
Page 3

acquisition as well as coordination of laboratory analysis and data evaluation.

1981-1983 Old Dominion University - Graduate School Research Assistant. Served as graduate assistant in charge of water chemistry laboratory and conducted research on chemical treatment of surface potable water source.

1976-1981 U.S. Navy, Commissioned Officer. Responsible for the supervision of assigned personnel including job scheduling and performance evaluation, for the upkeep of major equipment, for preparation of operational exercises and reports and administration of division budget. Coordinated scheduling and tracking of ship's force and commercial shipyard efforts during major overhaul.

Education

B.S., 1976, United States Naval Academy
M.E., 1983, Environmental Engineering, Old Dominion University

Professional Affiliations

Registered Professional Engineer in Georgia

Biographical Data

A. SCOTT YANKEY
Hydrogeologist

Experience Summary

Experience in design and implementation of groundwater monitoring plans at hazardous waste sites throughout the U.S. Specialized experience in geophysical assessment of hazardous waste sites and hydrogeologic interpretation.

Experience Record

- | | |
|-----------|---|
| 1985-Date | Engineering-Science. <u>Hydrogeologist</u> . Responsible for geophysical and hydrogeological investigations at active and inactive hazardous waste sites. Geophysical investigations include surface electrical resistivity, electromagnetic and magnetic surveys to delineate subsurface stratigraphy, site boundaries, hydrogeologic features, and contaminant plumes migrating from sites. Hydrogeologic investigations include utilizing geophysical data for evaluating existing groundwater monitoring systems and placement of new groundwater monitoring wells; ground water, surface water and soil sampling; pumping tests; and report preparation. |
| 1981-1982 | Self-employed <u>Geologist</u> . Responsible for researching existing oil and gas well records and collating the data for the eastern, southern and western producing counties of Kentucky. Involved geophysical log interpretation to identify contacts and marker horizons. |
| 1980 | University of Kentucky, Black Shale Project, Lexington, Kentucky, <u>Geologist</u> . Responsible for the identification and separation of microfossil assemblages within the Chattanooga Shale and mapping their occurrence throughout Kentucky. |

Education

B.S. Geology, 1983, University of Kentucky
M.S. Geology, Active, University of Georgia

APPENDIX D
BORING LOGS, WELL COMPLETION FORMS,
WELL CONSTRUCTION DIAGRAMS

BORING LOGS

ENGINEERING-SCIENCE DRILLING RECORD

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WELL/BORING ID: MDB-1	DRILLING STARTED: 1510 9/18/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1545 9/18/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 3.25
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/9/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	3/7/18			Topsoil and vegetation	
3.0				Sand, quartz, fine to gravel, white to gray, limestone fragments (fill material)	
5.0	5/5/6			Sand, quartz, fine to very fine, brown, plant material	HNu = 0.8 ppm
10.0	2/3/5			Sand, quartz, fine to very fine, white to tan, scattered heavy minerals	HNu = 0.0 ppm
15.0	4/4/6			Sand, quartz, medium to very fine, gray, clay 20%, limey gravel zone at 16'	
20.0	1/1/2			Clay, gray-green, sand 40%, pebble to very fine, quartz, limestone fragments <10 mm, plant material	HNu = 0.0 ppm
				Terminated boring at 22 feet	

ENGINEERING-SCIENCE DRILLING RECORD

PAGE 1 OF 1

WELL/BORING ID: MDB-2	DRILLING STARTED: 1610 9/18/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1645 9/18/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 3.70
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/9/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	2/1/1			Topsoil and vegetation Sand, quartz, fine to very fine, brown to tan, plant material	HNu = 0.4 ppm
5.0	3/5/6			Sand, quartz, fine to very fine, tan, plant material	HNu = 0.0 ppm
10.0	3/3/4			Sand, quartz, fine to very fine, slightly silty, slightly clayey, white to tan	HNu = 0.0 ppm
14.0	3/4/4			Sand, quartz, fine to very fine, clay 30-40%, gray to gray-green Terminated boring at 17 feet	

ENGINEERING-SCIENCE DRILLING RECORD

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WELL/BORING ID: MDB-3	DRILLING STARTED: 9/18/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 9/18/86
PROJECT NO: AT001	DRILLING METHOD: Rotary/Auger
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 3.97
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/9/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	4/7/5			Topsoil and vegetation Sand, quartz, fine to very fine, limestone fragments, <6 mm in diameter	HNu = 0.0 ppm
1.0				Sand, quartz, fine to very fine, gray to black, decaying vegetation	
5.0	4/4/6			Sand, quartz, fine to very fine, brown, plant material	HNu = 0.0 ppm
10.0	2/2/3			Sand, quartz, silt to fine, clay 5-10%, tan	
14.0				Clay, sandy, gray-green	
15.0	1/2/2			Sand, quartz, fine to very fine, clay 50%, gray-green, limestone fragments	Tool fell under weight of hammer to 23.5 feet. Hole filled with ben- tonite to depth of 14 feet

ENGINEERING-SCIENCE DRILLING RECORD

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WELL/BORING ID: MDB-4	DRILLING STARTED: 0735 9/18/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 0755 9/18/86
PROJECT NO: AT001	DRILLING METHOD: Rotary/Auger
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 3.20
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/9/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	5/5/3			Topsoil, vegetation and fill material: sand, quartz, fine to very fine, limestone fragments <6 mm diameter. Sand, quartz, fine to very fine, gray to brown	HNu = 0.0 ppm
5.0	3/4/6			Sand, quartz, fine to very fine, plant material, gray	HNu = 0.0 ppm
10.0	2/3/3			Sand, quartz, fine to very fine, white to light gray, sparse scattered heavy minerals, sparse plant material	
15.0	2/3/3			Sand, as above	
15.9				Sand, quartz, coarse to fine at contact, limestone fragments <5 mm diameter	
16.0				Clay, gray to gray-green, sand 40%, quartz, fine to silt	
				Terminated boring at 17 feet	

ENGINEERING-SCIENCE DRILLING RECORD

PAGE 1 OF 1

WELL/BORING ID: MDB-5	DRILLING STARTED: 8-15-87
LOCATION: MacDill AFB	DRILLING COMPLETED: 8-15-87
PROJECT NO: AT001	DRILLING METHOD: Hollow Stem Auger
DRILLER: Diversified Drilling	SAMPLING METHOD: Grab
LOGGER:	STATIC WATER LEVEL:
GEOLOGIST: R. S. Bonner	WATER LEVEL DATE:
SIGNATURE:	WATER LEVEL DATUM:

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0				Sand - very fine to fine, light tan with some gravel.	2" blacktop. Photo Vac TIP = 0 ppm at 0'.
1.0			1	Sand - medium to very fine, dark brown with trace silt, moist.	
3.0				Sand - medium to very fine, brown to black, little silt, moist.	
5.0			2	Sand - very fine to fine, dark gray, little silt, very wet.	Photo Vac TIP = 0 ppm at 5'.
8.0				Sand - very fine to fine, light gray, little silt, very wet.	
10.0			3		Photo Vac TIP = 0 ppm at 10'.
13.0				Boring Terminated at 13 feet.	

ENGINEERING-SCIENCE DRILLING RECORD

PAGE 1 OF 1

WELL/BORING ID: MD3-6	DRILLING STARTED: 1720 9/17/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1745 9/18/86
PROJECT NO: AT001	DRILLING METHOD: Rotary/Auger
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 3.56
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/10/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	2/4/5			Topsoil and vegetation. Sand, quartz, fine to very fine, gray-to-black, organic rich (decaying vegetation).	HNu: 0.0 ppm
5.0	4/4/2			Sand, quartz, fine to very fine, brown, organic-rich (decaying vegetation), coarse sand 5.0 to 5.5 feet.	HNu: 0.0 ppm
10.0	1/1/1			Sand, quartz, fine to very fine, chocolate brown, organic-rich (decaying vegetation), scattered coarse sand grains.	HNu: 0.0 ppm
14.0				Clay, brown, sand 30%, fine to silt.	
14.5				Limestone, weathered, clayey, white, fragmented <25 mm diameter. Terminated boring at 15 feet.	

ENGINEERING SCIENCE DRILLING RECORD

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WELL/BORING ID: MD58-5	DRILLING STARTED: 0755 9/18/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 0820 9/18/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 1.88
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/10/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0.0	1/3/3			Topsoil and vegetation. Sand, quartz, fine to very fine, white to gray.	HNu: 0.0 ppm
5.0	3/4/5			Sand, quartz, fine to very fine, silty, clayey, gray, clay 5-10%.	
10.0	3/4/5			Sand, quartz, fine to very fine, silty, slightly clayey, gray.	HNu: 0.0 ppm
15.0	3/4/5			Clay, stiff, blue-green, abundant shell fragments at 15.0 feet, sand 10%, quartz, very fine.	HNu: 0.0 ppm
20.0	5/8/9			Clay, stiff, blue-green, sand 10%, quartz, very fine, scattered shell fragments. Terminated boring at 22 feet.	

ENGINEERING-SCIENCE DRILLING RECORD

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WELL/BORING ID: MD58-6	DRILLING STARTED: 1815 9/17/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1825 9/17/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 4.58
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/12/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	1/2/3			Topsoil and vegetation Sand, quartz, fine to very fine, white to black, dark zone organic-rich (vegetation decay).	
5.0	6/7/10			Sand, quartz, fine to very fine, chocolate brown, organic-rich (vegetation decay).	HNu = 0.0 ppm
8.0				Clay, blue-green, stiff, slightly sandy, plant material, shell fragments	
				Terminated boring at 10 feet	

ENGINEERING-SCIENCE DRILLING RECORD

PAGE 1 OF 1

WELL/BORING ID: MD9-4	DRILLING STARTED: 09:10 9/18/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 09:45 9/18/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 4.06
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/14/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0.0	2/3/7			Topsoil and vegetation. Sand, quartz, fine to very fine, gray.	HNu: 1.0 ppm
5.0	3/5/7			Sand, as above	
7.0				Clay, sand 50%, quartz, fine to very fine, gray.	
10.0	2/3/3/			Clay, stiff, blue-green, sand 15-20%, quartz, very fine, scattered shell fragments.	HNu: 0.0 ppm
15.0	4/3/5			Clay, as above. Terminated boring at 17 feet.	

ENGINEERING-SCIENCE DRILLING RECORD

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WELL/BORING ID: MD9-5	DRILLING STARTED: 1350 9/18/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1415 9/18/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 5.11
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/14/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	3/5/5			Topsoil and vegetation. Sand, quartz, fine to very fine, gray to black, organic rich (vegetation decay).	HNu: 0.0 ppm
3.0				Sand, quartz, fine to very fine, brown to black, organic rich (vegetation decay).	
5.0	3/3/4			Sand, quartz, fine to silt, Clay 20%, plant material, gray.	HNu: 0.0 ppm
6.0				Clay, blue-green, stiff.	
9.5				Limestone: weathered, tan to white, fragmented.	
10.0				Terminated boring at 10 feet.	Hole backfilled with bentonite to depth of 9.3 feet.

ENGINEERING-SCIENCE DRILLING RECORD

PAGE 1 OF 1

WELL/BORING ID: MD9-6	DRILLING STARTED: 1310 9/18/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1330 9/18/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 5.43
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/14/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	1/3/5			Topsoil and vegetation. Sand, quartz, fine to very fine, gray to black, organic rich in upper foot (vegeta- tion decay).	HNu: 0.4 ppm
5.0	7/9/6			Sand, quartz, fine to very fine, brown to black, organic rich (vegetation decay), coral fragments at 6.5 feet.	HNu: 0.0 ppm
6.5				Sand, quartz, fine to very fine, silty clay 20%, gray.	
10.0	4/5/9			Sand, as above.	
15.0	5/9/11			Clay, blue-green, sand 15% quartz, fine, scattered shell fragments. Terminated boring at 17 feet.	

ENGINEERING-SCIENCE DRILLING RECORD

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WELL/BORING ID: MD9-7	DRILLING STARTED: 1010 9/18/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1125 9/18/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 4.67
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/14/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	1/3/7			Topsoil and vegetation. Sand, quartz, fine to very fine, gray.	HNu: 1.0 ppm
5.0	6/7/12			Sand; quartz, fine to very fine, clay 50%, gray to brown.	HNu: 1.4 ppm
8.5				Sand, quartz, medium to very fine, clay 50%, abundant fine to medium shell fragments, gray- green.	
10.0	4/4/7				HNu: 0.0 ppm
15.0	9/8/10			Clay, blue-green, stiff, sand 15%, fine to very fine, scattered fine shell fragments. Terminated boring at 17 feet.	

ENGINEERING-SCIENCE DRILLING RECORD

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WELL/BORING ID: MD13-1	DRILLING STARTED: 0955 9/17/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1025 9/17/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 7.09
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/17/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	2/11/13			Topsoil and vegetation. Sand, quartz, fine to very fine, gray, fill material.	
5.0				Sand, quartz, fine to very fine, tan.	
10.0	2/5/7			Sand, quartz, fine to very fine, tan to brown.	
15.0	5/9/9			Sand, quartz, fine to very fine, silty at 16.0 feet, tan to brown.	
20.0	5/8/8			Sand, quartz, fine to very fine, slightly silty, tan to brown.	
25.0	5/6/9			Sand, quartz, fine to silty, brown.	
				Terminated boring at 27 feet.	

ENGINEERING-SCIENCE DRILLING RECORD

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WELL/BORING ID: MD13-2A	DRILLING STARTED: 1300 9/17/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1330 9/17/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 7.85
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/17/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	1/2/7			Topsoil and vegetation; sand, quartz, fine to very fine, black, organic-rich (vegetation decay).	HNu: 0.0 ppm
5.0	1/1/2			Sand, quartz, fine to very fine, silty, brown to gray, organic-rich (vegetation decay).	HNu: 0.0 ppm
10.0	1/4/3			Sand, quartz, fine to very fine, silty, slightly clayey, tan-to-white.	
15.0	3/3/4			Sand, quartz, fine to very fine, silty, slightly clayey, gray.	
20.0				Sand, quartz, fin to very fine, clay 50%, gray; hammer fell to 28 feet with no resistance.	
28.0				Limestone, weathered, white.	Hole backfilled with bentonite to a depth of 14 feet, then grouted to surface.

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WELL/BORING ID: MD13-2B	DRILLING STARTED: 1000 9/23/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1030 9/23/86
PROJECT NO: AT001	DRILLING METHOD: Auger
DRILLER: Diversified Drilling	SAMPLING METHOD: Cuttings
LOGGER:	STATIC WATER LEVEL: 7.85
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/17/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0				Topsoil and vegetation. Sand, quartz, fine to very fine, black to dark gray, plant material.	HNu: 0.0 ppm
4.0				Sand, quartz, fine to very fine, gray.	
5.0					HNu: 0.0 ppm
10.0				Sand, as above.	HNu: 0.0 ppm
15.0				Sand, quartz, fine to very fine, black to dark gray.	
20.0				Sand, quartz, fine to very fine, gray.	
				Terminate boring at 22.0 feet.	

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WELL/BORING ID: MD13-3	DRILLING STARTED: 1200 9/17/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1225 9/17/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 7.58
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/17/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	2/3/5			Sand, quartz, fine to very fine, brown to black, organic-rich (vegetation decay).	HNu: 0.0 ppm
5.0	5/6/8			Sand, quartz, fine to very fine, white to tan, slightly silty.	
10.0	2/4/4			Sand, quartz, fine to very fine, white to tan.	
15.0	3/4/9			Sand, quartz, fine to very fine, silty, slightly clayey, white to brown.	HNu: 0.0 ppm
20.0	5/7/9			Sand, quartz, fine to very fine, silty, slightly clayey, gray. Terminated boring at 22 feet.	

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WELL/BORING ID: MD17-3	DRILLING STARTED: 9/17/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 9/17/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 7.71
GEOLOGIST: W. J. Duncan	WATER LEVEL DATE: 10/13/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	9/12/10			Topsoil and vegetation. Sand, quartz, fine to very fine, white to gray.	
5.0	6/9/7			Sand, quartz, fine to very fine, brown, organic-rich (vegetation decay).	
10.0	5/5/6			Sand, quartz, fine to very fine, white to brown.	
15.0	8/10/16			Sand, quartz, fine to very fine, silty, white to brown.	
16.0				Sand, quartz, fine to very fine, silty, brown.	
20.0	8/8/16			Sand, as above. Terminated boring at 22 feet.	

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WELL/BORING ID: MD17-4	DRILLING STARTED: 8-13-87
LOCATION: MacDill AFB	DRILLING COMPLETED: 8-14-87
PROJECT NO: AT001	DRILLING METHOD: Hollow Stem Auger
DRILLER: Diversified Drilling	SAMPLING METHOD: Grab
LOGGER:	STATIC WATER LEVEL:
GEOLOGIST: R. S. Bonner	WATER LEVEL DATE:
SIGNATURE:	WATER LEVEL DATUM:

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0				Sand - very fine, black, some silt, trace organics.	Top soil 0-.5'. Photo Vac TIP = 0 ppm at 1'.
.05			1	Sand - very fine to fine, gray, little silt.	
3.0				Sand - very fine, brown.	
5.0			2		Photo Vac TIP = 0 ppm at 5'
7.0				Sand - very fine to fine, tan.	
10.0			3		Photo Vac TIP = 0 ppm at 10'.
15.0			4		Photo Vac TIP = 0 ppm at 15'.
18.5				Boring Terminated at 18.5 feet.	

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WELL/BORING ID: MD23-7	DRILLING STARTED: 1505 9/19/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1540 9/19/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 5.42
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/16/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW L.S.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	15/4/4			Fill material: sand, quartz fine to very fine, limestone fragments. Sand, quartz, fine to very fine, gray to brown.	HNu: 0.1 ppm
1.0				Sand, quartz, fine to very fine, dark gray.	
5.0	4/6/8			Sand, quartz, fine to very fine, slightly clayey, gray.	
10.0	7/10/9			Sand, quartz, fine to silt, clay 40%, gray to blue-gray, glauconitic.	HNu: 0.0 ppm
15.0	4/6/8			Clay, gray-blue to green, glauconitic and phosphatic, sand 30-40%, very fine to silt, shell fragments at 19.0 feet.	
20.0	6/6/8			Clay, blue-green, glauconitic, sand 50%, medium to very fine. Terminated boring at 22 feet.	

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WELL/BORING ID: MD23-8	DRILLING STARTED: 1005 9/22/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1030 9/22/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 2.35
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/16/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	1/2/3			Topsoil and vegetation. Sand, quartz, fine to very fine, gray to dark gray, plant material.	HNu: 0.4 ppm
5.0	3/8/8			Sand, quartz, fine to very fine, clay 10-15%, light brown to gray.	
10.0	6/7/9			Sand, quartz, fine to very fine, gray, slightly clayey.	
15.0	6/7/11			Sand, as above.	
20.0				Sand, quartz, fine to very fine, clay 20%, black with gray streaks.	HNu: 0.2 ppm
21.0				Sand, quartz, fine to very fine, clay 40-50%, blue- gray. Terminated boring at 22 feet.	HNu: 0.4 ppm

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WELL/BORING ID: MD23-9	DRILLING STARTED: 0930 9/22/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 0955 9/22/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 4.13
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/16/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	2/1/2			Topsoil and vegetation. Sand, quartz, fine to very fine, plant material, gray.	HNu: 0.3 ppm
4.0				Sand, quartz, fine to very fine, brown, calcite cement, shell fragments.	
5.0	3/5/5			Sand, quartz, fine to silt, clay 5-10%, gray to brown.	HNu: 0.2 ppm
10.0	3/4/5			Sand, quartz, fine to very fine, clay 5%, gray.	
12.0				Sand, quartz, fine to very fine, clay 50-60%, gray-blue.	
15.0	2/2/3			Sand, quartz, fine to silt, clay 50-60%, shell fragments, quartz pebbles, scattered heavy minerals, calcareous clay. Terminated boring at 17 feet.	HNu: 0.1 ppm

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WELL/BORING ID: MD23-10	DRILLING STARTED: 1415 9/19/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1445 9/19/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 6.93
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/16/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	2/2/6			Topsoil and vegetation. Sand, quartz, fine to very fine, gray to dark gray.	HNu (hole): 6.8 ppm; HNu (sample): 0.0 ppm.
5.0	3/3/6			Sand, quartz, fine to silt, clay 40-50%, gray to dark gray, organic rich (vegetation decay).	HNu (hole): 0.0 ppm; HNu (sample): 0.0 ppm.
10.0	3/3/4			Sand, quartz, fine to silt, clay 30%, calcareous, abundant shell fragments (up to 5 mm diameter) and heavy minerals.	
15.0	3/6/9			Sand, quartz, medium to silt, clay 50%, galuconitic, shell fragments, gray-green to blue green. Terminated boring at 17 feet.	

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WELL/BORING ID: MD23-11	DRILLING STARTED: 1330 9/19/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1355 9/19/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 5.33
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/15/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	1/1/1			Topsoil and vegetation. Sand, quartz, fine to very fine, plant material, gray.	HNu: 0.0 ppm
3.0				Sand, quartz, fine to very fine, abundant shell frag- ments, few quartz pebbles, calcite cement.	
5.0	3/3/3			Sand, as above.	
6.0				Sand, quartz, fine to very fine, shell fragments, gray.	
10.0	4/4/4			Sand, quartz, fine to silt, clay 20-30%, gray to blue gray, shell fragments up to 20 mm (longest axis).	
15.0	1/2/5			Sand, quartz, fine to very fine, calcareous clay 30-40%, abundant shell fragments and heavy minerals.	
19.0				Clay, blue-green, very stiff, abundant quartz, well rounded to subangular pebbles, shell fragments 1-20 mm (longest axis).	
20.0	3/3/4			Clay, as above. Terminated boring at 22 feet.	

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WELL/BORING ID: MD23-12	DRILLING STARTED: 0905 9/19/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 0940 9/19/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 7.21
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/15/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	2/2/5			Topsoil and fill material: sand, limestone fragments, brick fragments. Sand, quartz, fine to very fine, gray.	HNu: 0.1 ppm
5.0	5/5/6			Sand, quartz, fine to very fine, gray.	
6.0				Sand, quartz, fine to very fine, clay 30-40%, plant material, gray-green.	
8.0				Sand, quartz, fine to silt, slightly clayey, gray.	
10.0	4/6/8			Sand, quartz, fine to silt, clay 20%, blue-gray.	
15.0	4/6/5			Sand, quartz, fine to very fine, slightly silty, clay 10-15%, gray to blue-gray.	HNu: 0.0 ppm
20.0	2/2/2			Sand, quartz, fine to silt, clay 30%, scattered rounded quartz pebbles, abundant limestone, shell, and coral fragments. Terminated boring at 20 feet.	Hole backfilled with bentonite to depth of 15 feet.

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WELL/BORING ID: MD23-13	DRILLING STARTED: 1030 9/19/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1055 9/19/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 7.52
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/15/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0				Topsoil and vegetation. Sand, quartz, fine to very fine, gray.	HNu: 0.3 ppm
5.0	3/3/3			Sand, quartz, fine to silt, abundant shell fragments up to 8 mm (longest axis) clay 5-10%.	
7.0				Sand, quartz, fine to very fine, dark gray.	
10.0	5/6/7			Sand, quartz, fine to silt, slightly clayey, gray.	
15.0	6/9/5			Clay, blue-green, very stiff, scattered brown (limonitic) streaks. Terminated boring at 17 feet.	

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WELL/BORING ID: MD23-14	DRILLING STARTED: 1100 9/19/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1137 9/19/86
PROJECT NO: AT001	DRILLING METHOD: Auger/Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 6.99
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/15/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW L.S.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	1/2/3			Topsoil and vegetation. Sand, quartz, fine to very fine, gray.	HNu: 0.0 ppm
3.0				Sand, quartz, fine to silt, abundant shell fragments, clay 20%, brown to gray.	
5.0	4/5/4			Sand, as above.	
10.0	4/5/5			Sand, quartz, fine to silt, clay 30%, scattered shell fragments up to 3mm (longest axis), gray.	
15.0	3/3/4			Sand, quartz, fine to silt, slightly clayey, abundant scattered shell fragments and heavy minerals. Terminated boring at 17 feet.	

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WELL/BORING ID: MD23-15	DRILLING STARTED: 1105 9/25/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1130 9/25/86
PROJECT NO: AT001	DRILLING METHOD: Auger
DRILLER: Diversified Drilling	SAMPLING METHOD: Cuttings
LOGGER:	STATIC WATER LEVEL: 5.55
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/15/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0				Topsoil and vegetation. Sand, quartz, fine to very fine, plant material, gray.	HNu: 0.0 ppm
4.0				Sand, quartz, fine to very fine, clay 30%, scattered shell fragments <1mm to 5mm (longest axis), tan.	
5.0					HNu: 0.0 ppm
8.0				Sand, quartz, fine to very fine, clay 10%, silty, sparse shell fragments.	
10.0					HNu: 0.0 ppm
15.0				Clay, no sample recovered. Auger cutting very slowly. Terminated boring at 17 feet.	

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WELL/BORING ID: MD23-D1	DRILLING STARTED: 1130 9/29/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1345 9/29/86
PROJECT NO: AT001	DRILLING METHOD: Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 2.00
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/17/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	8/9/4			Fill material: sand and limestone fragments. Sand, quartz, fine to very fine, gray.	HNu: 0.0 ppm
5.0	2/4/6			Clay, gray to dark gray, sand 30%, quartz, fine to silt, plant material.	HNu: 0.0 ppm
10.0	7/4/4			Sand, quartz, fine to very fine, clay 30%, light gray.	HNu: 0.0 ppm
15.0	3/5/8			Sand, quartz, fine to silt, very silty, clay 30%, gray to gray-brown.	
20.0	3/4/4			Silty sand, as above.	
25.0	4/9/10			Sand, quartz, fine to silt, very silty, clay 20-30%, gray.	
30.0	7/9/86			Sand, quartz, fine to silt, cemented and hard, scattered quartz pebbles, clay concretions, and limestone fragments.	
35.0	5/12/20			Clay, blue-green with dark gray to black streaks, sand 10%.	

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WELL/BORING ID: MD23-D1	DRILLING STARTED: 1130 9/29/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1345 9/29/86
PROJECT NO: AT001	DRILLING METHOD: Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 2.00
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/17/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
40.0	4/4/3			Clayey silt, clay 15-20%, gray to tan.	
45.0	4/5/5			Clayey silt, clay 20%, gray to tan, slightly sandy, very fine, some sand grains cemented.	
50.0	100/0/0			Limestone, highly weathered and fragmented, white to cream.	
63.1				Limestone as above. Terminated boring at 63.1 feet.	

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WELL/BORING ID: MD23-D2	DRILLING STARTED: 1210 9/30/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1700 10/2/86
PROJECT NO: AT001	DRILLING METHOD: Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 1.76
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/19/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	1/1/5			Sand, quartz, fine to very fine, gray to dark gray, plant material.	HNu: 0.0 ppm
2.0				Sand, quartz, fine to very fine, brown with dark streaks, slightly clayey.	
5.0	3/5/10			Sand, quartz, fine to very fine, dark gray to dark brown.	HNu: 0.0 ppm
10.0	6/7/8			Sand, quartz, fine to silt, clay 10%, gray-brown.	
15.0	1/2/3			Sand, quartz, fine to very fine, clay 5-10%, black to dark gray, decaying plant odor.	HNu: 0.0 ppm
19.0				Clay, gray to dark gray, 40% shell fragments <1 to 7 mm (longest axis), sand 15-20%, quartz, medium to fine.	
20.0	4/2/1			Clay, as above.	
25.0	3/3/3			Sand, quartz, medium to very fine, scattered shell fragments (<4mm diameter) and heavy minerals, slightly clayey.	

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WELL/BORING ID: MD23-D2	DRILLING STARTED: 1210 9/30/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1700 10/2/86
PROJECT NO: AT001	DRILLING METHOD: Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 1.76
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/19/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
29.0				Clay, blue-green, very stiff, slightly sandy.	
30.0	2/6/7			Clay, as above.	
35.0	6/11/15			Clay, blue-green to blue-gray, sand 40%, quartz, medium to very fine, scattered cement, very stiff.	HNu: 0.0 ppm
40.0	13/24/29			Clay, as above, sand 50%	HNu: 0.0 ppm
45.0	12/15/18			Sand, quartz, fine to very fine, clay 40%, scattered shell fragments, blue-gray to blue-green.	
50.0				Clay, cemented, scattered carbonaceous material, very hard and brittle, blue-green laminated 1-3mm thick.	
55.0	Refusal after 50 blows penetrated <1 inch			Cemented clay, as above.	
60.0	50 blows penetrated 4 inches			Limey clayey sand, sand 40%, fine to very fine, clay 30%, some calcium carbonate cement, tan with dark streaks.	

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WELL/BORING ID: MD23-D2	DRILLING STARTED: 1210 9/30/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1700 10/2/86
PROJECT NO: AT001	DRILLING METHOD: Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 1.76
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/19/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
65.0	5/23/0			Limey clay, tan to blue-gray, silty, slightly sandy, scattered carbonaceous material, organic decay odor.	HNU: 0.0 ppm Samples at 80 to 90 feet obtained by cuttings.
70.0	50 blows penetrated 6 inches.			Limey silt, buff, scattered limestone fragments.	
75.0	50 blows penetrated 6 inches.			Limestone, weathered, buff to light gray, silty, slightly sandy.	
80.0				Limestone, fossiliferous, white, sparse cherty fragments.	
85.0				Limestone, slightly sandy and clayey, white to buff.	
90.0				Limey silty clay, white. Terminated boring at 90 feet.	

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WELL/BORING ID: MD23-D3	DRILLING STARTED: 0915 9/30/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1200 10/2/86
PROJECT NO: AT001	DRILLING METHOD: Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 1.85
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/17/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW L.S.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0	2/2/4			Sand, quartz, fine to very fine, plant material, light gray to black.	HNu: 0.0 ppm
5.0	4/5/8			Sand, quartz, fine to silt, silty, clay 20-3-%, gray, scattered plant material.	HNu: 0.0 ppm
10.0	2/2/5			Sand, quartz, fine to very fine, clay 5%, shell fragments u to 10mm (longest axis), scattered subrounded quartz pebbles and heavy minerals, brown, calcareous.	HNu: 0.0 ppm
15.0	3/4/5			Clay, blue-green, very stiff, brown streaks.	
20.0	8/14/17			Silty clay, slightly sandy, gray to gray-brown, brown-red streaks, stiff, very dry.	HNu: 0.0 ppm
25.0	4/12/18			Silty clay, sand 30%, quartz very fine, gray to to blue-gray, stiff.	HNu: 0.0 ppm
30.0	11/22/31			Silty clay, sand 30-40%, quartz, scattered silica cement, gray to gray-blue, stiff.	HNu: 0.0 ppm

ENGINEERING-SCIENCE DRILLING RECORD

PAGE 2 OF 2

WELL/BORING ID: MD23-D3	DRILLING STARTED: 0915 9/30/86
LOCATION: MacDill AFB	DRILLING COMPLETED: 1200 10/2/86
PROJECT NO: AT001	DRILLING METHOD: Rotary
DRILLER: Diversified Drilling	SAMPLING METHOD: Split Spoon
LOGGER:	STATIC WATER LEVEL: 1.85
GEOLOGIST: A. Scott Yankey	WATER LEVEL DATE: 10/17/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
35.0	16/46/40			Limey clay, sand 40%, quartz, fine to very fine, limestone fragments, buff to light gray.	
40.0	50 blows penetrated 1 inch			Weathered limestone, cream to white, fragmented, fossiliferous.	No sample
45.0	34/14/16			Limestone, silty, sand 10-20%, quartz, fine to very fine, fossiliferous limestone fragments up to 15mm (longest axis).	
50.0	20/42/29			Limestone, sand 30-40%, quartz, fine to very fine, clay 10-20%, limestone fragments <1mm to 10mm diameter, cream to light gray.	
55.0	5/10/11			Limey silty sand, sand 60%, quartz, fine to silt, clay 20%, limestone fragments 20%, <1mm to 3mm diameter, light gray to buff. Terminated boring at 55 feet.	Lost some drilling fluid.

ENGINEERING-SCIENCE DRILLING RECORD

PAGE 1 OF 1

WELL/BORING ID: AP-6-4	DRILLING STARTED: 10/6/86
LOCATION: Avon Park Site 6	DRILLING COMPLETED: 10/6/86
PROJECT NO: AT001	DRILLING METHOD: Auger
DRILLER: Diversified Drilling	SAMPLING METHOD: Cuttings
LOGGER:	STATIC WATER LEVEL: 55.39
GEOLOGIST: W. J. Duncan	WATER LEVEL DATE: 10/28/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0.0				Topsoil Sand, quartz, medium to fine, white to gray, slightly silty, some organic (vegetation) material.	Dry
5.0				Sand, quartz, medium to fine, clay 15%, silty, brown to gray.	Damp
10.0				Sand, quartz, fine to very fine, clay 40%, silty, gray- brown.	Wet
15.0				Sand, quartz, medium to fine, clay 40%, silty, gray-brown.	Wet
17.0				Clay, very sandy, sticky, gray-green.	
20.0				Clay as above. Terminated boring at 20 feet.	

ENGINEERING-SCIENCE DRILLING RECORD

PAGE 1 OF 1

WELL/BORING ID: AP7-4	DRILLING STARTED: 10/7/86
LOCATION: Avon Park Site 7	DRILLING COMPLETED: 10/7/86
PROJECT NO: AT001	DRILLING METHOD: Auger
DRILLER: Diversified Drilling	SAMPLING METHOD: Cuttings
LOGGER:	STATIC WATER LEVEL: 59.39
GEOLOGIST: W. J. Duncan	WATER LEVEL DATE: 10/28/86
SIGNATURE:	WATER LEVEL DATUM: MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0				Topsoil and vegetation.	
1.0				Sand, quartz, medium to fine, silty, organic vegetation, black-brown.	Dry
5.0				Silt, organic rich (vegeta- tion), sand 15%, black.	Wet
10.0				Sand, quartz, medium to fine, silty, clay 20%, black.	Wet
16.0				Sand, quartz, medium to fine, silty, slightly clayey, gray- green.	Wet
20.0				Sand, as above. Terminated boring at 20 feet.	Wet

WELL COMPLETION FORMS

WELL COMPLETION REPORT

Owner's Name Engineering- Science
 Permit Number 420615-11 MD9-5
 X W. F. Fife 9-25-86
 Water Well Contractor's Signature Completion Date
 License No. 1232

SURFACE CASING, CASING AND LINER MATERIAL:

Types	Diam. (In.)	From (Ft.)	To (Ft.)
PVC	2	-4	+2.5
PVC Screen	2	-14	-4
Neat Cement No. of Bags	From (Ft.)	To (Ft.)	
Hole plug	1.5	-3	-2
Sand	5	-14.5	-3

IRON: ___ ppm SULFATES: ___ ppm CHLORIDES: ___ ppm
 FINISH: Screen: 10 (Ft.) Open Hole: ___ (Ft.)

WELL LOCATION

___ % ___ % of Section 34

<u>30</u>	<u>S</u>	<u>18</u>	<u>E</u>	Locate in Section } Optional may be required
Township	(N-S)	Range	(E-W)	
Latitude		Deg.	Min.	
Longitude		Sec.	W	

Please complete in black ink or type

WELL COMPLETION REPORT

Owner's Name Engineering-Science
 Permit Number 420615-11 MD9-7
 X W. F. Fife 9-24-86
 Water Well Contractor's Signature Completion Date
 License No. 1232

SURFACE CASING, CASING AND LINER MATERIAL:

Types	Diam. (In.)	From (Ft.)	To (Ft.)
PVC	2	-4	+2.5
PVC Screen	2	-14	-4
Neat Cement No. of Bags	From (Ft.)	To (Ft.)	
Hole plug	1	-3	-2
Sand	5	-14.1	-3

IRON: ___ ppm SULFATES: ___ ppm CHLORIDES: ___ ppm
 FINISH: Screen: 10 (Ft.) Open Hole: ___ (Ft.)

WELL LOCATION

___ % ___ % of Section 34

<u>30</u>	<u>S</u>	<u>18</u>	<u>E</u>	Locate in Section } Optional may be required
Township	(N-S)	Range	(E-W)	
Latitude		Deg.	Min.	
Longitude		Sec.	W	

DRILL METHOD

☐ Rotary ☐ Cable Tool ☐ Jet ☒ Auger Other ___
 Measured Static Water Level ___ + ___ Ft.
 Measured Pumping Water Level ___ + ___ Ft.
 After ___ Hours At ___ G.P.M.
 Measuring Pt. (Describe): top of casing
 Which is 2.5 Ft. ☒ Above ☐ Below Land Surface

Depth (Ft.)	Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
From To	
0 .5	Top soil and vegetation
.5 5	Sand, quartz, fine to very fine, gray to black, organic material near top (vegetation decay)
5 6.5	Sand, quartz, fine to very fine, brown to black, organic (vegetation decay) rich coral fragments on top of clayey sand
6.5 12	Sand, quartz, fine to silt, clay ~20%, gray
12 17	Clay, blue-green, sand fine to very fine ~15%, sparse scattered shell fragments
17	termination

Driller's Name Bobby Tinsley

Form No. 25-18-5/83

DRILL METHOD

☐ Rotary ☐ Cable Tool ☐ Jet ☒ Auger Other ___
 Measured Static Water Level ___ + ___ Ft.
 Measured Pumping Water Level ___ + ___ Ft.
 After ___ Hours At ___ G.P.M.
 Measuring Pt. (Describe): top of casing
 Which is 2.5 Ft. ☒ Above ☐ Below Land Surface

Depth (Ft.)	Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
From To	
0 .5	top soil and vegetation
.5 5	sand, quartz, fine to very fine, gr.
5 8.5	sand, quartz, fine to silt, clay ~50%, gray to brown
8.5 17	Clay, gray-green to blue-green, sand 15-40%, very fine to medium, scattered shell fragments
17	termination

Driller's Name Bobby Tinsley

Owner's Name **Engineering-Science**

**SURFACE CASING, CASING
AND LINER MATERIAL:**

IRON: _____ ppm SULFATES: _____ ppm CHLORIDES: _____ ppm
FINISH: Screen: 8 (Ft.) Open Hole: _____ (Ft.)

 % % % of Section 34

<div>30</div>	<div>S</div>	<div>18</div>	<div>E</div>	<div></div>
Township	(N-S)	Range	(E-W)	Locate in Section
Latitude	<div></div>	<div></div>	<div></div>	} Optional may be required
	Deg.	Min.	Sec.	
Longitude	<div></div>	<div></div>	<div></div>	
				W

Please complete in black ink or type

WELL COMPLETION REPORT

**SURFACE CASING, CASING
AND LINER MATERIAL:**

IRON: _____ ppm SULFATES: _____ ppm CHLORIDES: _____ ppm
FINISH: Screen: 5 (Ft.) Open Hole: _____ (Ft.)

____ % ____ % ____ % of Section 34

<div> <div>30</div> <div>Township</div> </div>	<div> <div>S</div> <div>(N-S)</div> </div>	<div> <div>18</div> <div>Range</div> </div>	<div> <div>E</div> <div>(E-W)</div> </div>	<div> <div></div> <div>Locate in Section</div> </div>
<div> <div>Latitude</div> <div></div> </div>	<div> <div></div> <div>Deg.</div> </div>	<div> <div></div> <div>Min.</div> </div>	<div> <div></div> <div>Sec.</div> </div>	<div> <div>N</div> <div>Optional may be required</div> </div>
<div> <div>Longitude</div> <div></div> </div>	<div> <div></div> </div>	<div> <div></div> </div>	<div> <div></div> </div>	<div> <div>W</div> </div>

[] Rotary [] Cable Tool [] Jet ☒ Auger Other _____
 Measured Static Water Level _____ + _____ Ft.
 Measured Pumping Water Level _____ + _____ Ft.
 After _____ Hours At _____ G.P.M.
 Measuring Pt. (Describe): top of casing
 Which is 2.5 Ft. ☒ Above [] Below Land Surface

[illegible]

Driver's Name Bobby Tinsley

Form No 25-10 5/83

DRILL METHOD

☐ Rotary ☐ Cable Tool ☐ Jet ☒ Auger Other _____
 Measured Static Water Level _____ + _____ Ft.
 Measured Pumping Water Level _____ + _____ Ft.
 After _____ Hours At _____ G.P.M.
 Measuring Pt. (Describe): top of casing
 Which is 2.5 Ft. ☒ Above ☐ Below Land Surface

Depth (Ft.)		Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary
From	To	
0	.3	top soil and vegetation
.3	3	sand, quartz, fine to very fine, gray to black, organic rich (vegetation decay)
3	6	sand, quartz, fine to very fine brown to black, rich in organic (vegetation decay) material
6	9.5	sand, quartz, fine to silt, clay ~20%, gray, sparse plant material
9.5	10	clay, blue-green
10		termination
		Filled hole to -9.3' with ~0.5 bags of holeplug (bentonite)

Driller's Name Bobby Tinsley

WELL COMPLETION REPORT

Owner's Name Engineering-Science

Permit Number 420612-14

MD23-13

X [Signature]
Water Well Contractor's Signature

9-25-86

Completion Date

License No 1232

SURFACE CASING, CASING AND LINER MATERIAL

Types	From (ft.)	To (ft.)	To (ft.)
PVC	2	-4	+2.5
PVC Screen	2	-14	-4
Neat Cement	No. of Bags	From (ft.)	To (ft.)
hole plug	1	-3	-2
sand	5	-14.2	-3

IRON 10 ppm SULFATES 10 ppm CHLORIDES 10 ppm
FINISH: Screen 10 (ft.) Open Hole 10 (ft.)

WELL LOCATION

21 % of Section

Township 30 (N-S) Range 18 (E-W) E
 Latitude Deg. Min. Sec. N } Optional may be required
 Longitude Deg. Min. Sec. W }

DRILL METHOD

☒ Rotary ☐ Cable Tool ☐ Jet ☒ Auger Other

Measured Static Water Level + Ft

Measured Pumping Water Level + Ft

After Hours At GPM

Measuring Pt (Describe) top of casing

Which is 2.5 Ft ☒ Above ☐ Below Land Surface

Depth (ft.)	From	To	Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
0	.5	2	top soil and vegetation
.5	2	7	sand, fine to very fine, quartz, gray
2	7	15	sand, quartz, fine to silt, abundant shell fragments up to 8mm diameter, clay ~5-10%
7	15	17	sand, quartz, fine to very fine, gray, slightly clayey
15	17	17	clay, blue-green, very stiff, brown streaks scattered
17			termination

Driller's Name Bobby Tinsley

Please complete in black ink or type

WELL COMPLETION REPORT

Owner's Name Engineering-Science

Permit Number 420612-14

MD23-14

X [Signature]
Water Well Contractor's Signature

9-25-86

Completion Date

License No 1232

SURFACE CASING, CASING AND LINER MATERIAL

Types	From (ft.)	To (ft.)	To (ft.)
PVC	2	-4	+2.5
PVC Screen	2	-14	-4
Neat Cement	No. of Bags	From (ft.)	To (ft.)
hole plug	1	-3	-2
sand	5	-14.2	-3

IRON 10 ppm SULFATES 10 ppm CHLORIDES 10 ppm
FINISH: Screen 10 (ft.) Open Hole 10 (ft.)

WELL LOCATION

21 % of Section

Township 30 (N-S) Range 18 (E-W) E
 Latitude Deg. Min. Sec. N } Optional may be required
 Longitude Deg. Min. Sec. W }

DRILL METHOD

☒ Rotary ☐ Cable Tool ☐ Jet ☒ Auger Other

Measured Static Water Level + Ft

Measured Pumping Water Level + Ft

After Hours At GPM

Measuring Pt (Describe) top of casing

Which is 2.5 Ft ☒ Above ☐ Below Land Surface

Depth (ft.)	From	To	Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
0	.5	3	top soil and vegetation
.5	3	17	sand, quartz, fine to very fine g
3	17	17	sand, quartz, fine to silt, abundant shell fragments brown to gray green, abundant scattered heavies
17			15-17', clay 20-30%
			Termination

Driller's Name Bobby Tinsley

WELL COMPLETION REPORT

Owner's Name Engineering-Science
 Permit Number 420609-14 MD23-11
 X W. J. Taylor 9-26-86
 Water Well Contractor's Signature Completion Date
 License No. 2232

SURFACE CASING, CASING AND LINER MATERIAL

Types	Diam. (in.)	From (Ft.)	To (Ft.)
PVC	4	-4	+2.5
PVC Screen	4	-19	-4
Near Cement No. of Bags			
Holeplug	1	-3	-2
Sand	7.5	-19.6	-3

IRON ppm SULFATES ppm CHLORIDES ppm
 FINISH: Screen 15 (Ft.) Open Hole (Ft.)

WELL LOCATION

 % % of Section 21

<u>30</u>	<u>S</u>	<u>18</u>	<u>E</u>
Township (N-S)	Range (E-W)	Locate in Section	
Latitude	Longitude	Optional may be required	

DRILL METHOD

☐ Rotary ☐ Cable Tool ☒ Jet ☒ Auger Other
 Measured Static Water Level + Ft.
 Measured Pumping Water Level + Ft.
 After Hours At G.P.M.
 Measuring Pt. (Describe) top of casing
 Which is 2.5 Ft. ☒ Above ☐ Below Land Surface

Depth (Ft.)	Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain size, and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
0 .5	top soil and vegetation
.5 3	sand, quartz, fine to very fine, gray, sparse plant material
3 6	sand, fine to very fine abundant shells and fragments
6 19	sand, quartz, fine to silt, clay 20-40%, gray to blue gray, abundant shell fragments 3-20 mm longest axis, very calcareous, heavy min. abundant 15-17'
19 22	clay, gray-green to blue-green, very stiff, abundant quartz well rounded pebbles and shell fragment 1-20mm
22	Termination

Driller's Name Bobby Tinsley

Please complete in black ink or type

WELL COMPLETION REPORT

Owner's Name Engineering-Science
 Permit Number 420610-14 MD23-12
 X W. J. Taylor 9-25-86
 Water Well Contractor's Signature Completion Date
 License No. 1232

SURFACE CASING, CASING AND LINER MATERIAL

Types	Diam. (in.)	From (Ft.)	To (Ft.)
PVC	2	-5	+2.5
PVC Screen	2	-15	-5
Near Cement No. of Bags			
hole plug	1	-3	-2
sand	6	-15	-3

IRON ppm SULFATES ppm CHLORIDES ppm
 FINISH: Screen 10 (Ft.) Open Hole (Ft.)

WELL LOCATION

 % % of Section 21

<u>30</u>	<u>S</u>	<u>18</u>	<u>E</u>
Township (N-S)	Range (E-W)	Locate in Section	
Latitude	Longitude	Optional may be required	

Form No. 25-18 5/83

DRILL METHOD

☐ Rotary ☐ Cable Tool ☒ Jet ☒ Auger Other
 Measured Static Water Level + Ft.
 Measured Pumping Water Level + Ft.
 After Hours At G.P.M.
 Measuring Pt. (Describe) Top of casing
 Which is 2.5 Ft. ☒ Above ☐ Below Land Surface

Depth (Ft.)	Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain size, and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
0 .5	top soil and fill material-sand quartz, fine to very fine, limestone fragments, brick fragments
.5 6	sand, quartz, fine to very fine, gray
6 8.5	sand, quartz, fine to silt, clay 30-40%, gray-green, plant material
8.5 18	sand, quartz, fine to silt, clay 10-20%, gray to blue-gray
18 20	sand, quartz, fine to silt, clay 30%, scattered pebbles of quartz, well rounded, angular shell coral fragments, 20%
20	termination
	filled with bentonite to total depth of 15'

Driller's Name Bobby Tinsley

WELL COMPLETION REPORT

Owner's Name Engineering-SciencePermit Number 420605-14 MD23-7X Water Well Contractor's Signature 9-25-86License No. 1232 Completion DateSURFACE CASING, CASING
AND LINER MATERIAL:

Types	Diam. (In.)	From (Ft.)	To (Ft.)
PVC	2	-5	+2.5
PVC Screen	2	-15	-5
Neat Cement	No. of Bags	From (Ft.)	To (Ft.)
hole plug	1		
sand	6.5	-15	

IRON: 10 ppm SULFATES: 10 ppm CHLORIDES: 10 ppmFINISH: Screen 10 (Ft.) Open Hole 10 (Ft.)

WELL LOCATION

10 % 10 % of Section 21

Township 30 (N-S) Range 18 (E-W) E Locate in Section 21
 Latitude 30 N 18 W E Optional may be required
 Longitude 30 Deg. 18 Min. E Sec. 21 W

DRILL METHOD

☐ Rotary ☐ Cable Tool ☒ Jet ☒ Auger Other Measured Static Water Level + Ft.Measured Pumping Water Level + Ft.After Hours At G.P.M.Measuring Pt. (Describe) top of casingWhich is 2.5 Ft. ☒ Above ☐ Below Land Surface

Depth (Ft.)	From	To	Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
0	.5		fill-sand, quartz, fine to very fine, limestone fragments
.5	1		sand, quartz, fine to very fine gray to brown
1	5		sand, quartz, fine to very fine, dark gray
5	10		sand, quartz, fine to very fine, slightly clayey 5-6', gray
10	15		sand, quartz, fine to silt, clay ~40-50%, gray to blue-gray glauconitic
15	20		clay, gray-blue to green, glauconitic sand ~30-40%, very fine to silt, shell fragments < 10mm diameter at
20	22		sand, medium-ven, clay ~50%, glauconitic
22			termination

Driller's Name Bobby Tinsley

Form No. 25 18-5/83

Please complete in black ink or type

WELL COMPLETION REPORT

Owner's Name Engineering-SciencePermit Number 420606-14 MD23-8X Water Well Contractor's Signature 9-26-86License No. 1232 Completion DateSURFACE CASING, CASING
AND LINER MATERIAL:

Types	Diam. (In.)	From (Ft.)	To (Ft.)
PVC	2	-5	+2.5
PVC Screen	2	-15	-5
Neat Cement	No. of Bags	From (Ft.)	To (Ft.)
holeplug	1	-3.5	-2.5
sand	6	-15.3	-3.5

IRON: 10 ppm SULFATES: 10 ppm CHLORIDES: 10 ppmFINISH: Screen 10 (Ft.) Open Hole 10 (Ft.)

WELL LOCATION

10 % 10 % of Section 21

Township 30 (N-S) Range 18 (E-W) E Locate in Section 21
 Latitude 30 N 18 W E Optional may be required
 Longitude 30 Deg. 18 Min. E Sec. 21 W

DRILL METHOD

☐ Rotary ☐ Cable Tool ☒ Jet ☒ Auger Other Measured Static Water Level + Ft.Measured Pumping Water Level + Ft.After Hours At G.P.M.Measuring Pt. (Describe) top of casingWhich is 2.5 Ft. ☒ Above ☐ Below Land Surface

Depth (Ft.)	From	To	Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
0	.5		top soil and vegetation
.5	5		sand, quartz, fine to very fine gray to dark gray, plant material
5	10		sand, quartz, fine to very fine, clay 10-15%, light brown to gray
10	20		sand, quartz, fine to very fine, gray, slightly clayey
20	21		sand, quartz, fine to silt, clay 10-20%, black with gray streaks
21	22		sand quartz, fine to silt, clay ~50-60%, blue gray
22			Termination

Driller's Name Bobby Tinsley

WELL COMPLETION REPORT

Owner's Name Engineering-Science
 Permit Number 420608-14 MD23-10
 X 9-25-86
 Water Well Contractor's Signature [Signature] Completion Date
 License No. 1232

SURFACE CASING, CASING AND LINER MATERIAL

Types	Diameter (In.)	From (Ft.)	To (Ft.)
PVC	2	-4	+2.5
PVC Screen	2	-14	-4
Neat Cement: No. of Bags			
hole plug	1	-3	-2
sand	6.5	-14.3	-3

IRON ppm SULFATES ppm CHLORIDES ppm
 FINISH: Screen 10 (Ft.) Open Hole (Ft.)

WELL LOCATION

 % % % of Section 21

Township 30 (N-S) Range 18 (E-W) Locate in Section

Latitude Deg. Min. Sec. N } Optional may be required
 Longitude W }

Please complete in black ink or type

WELL COMPLETION REPORT

Owner's Name Engineering-Science
 Permit Number 420607-14 MD23-9
 X 9-25-86
 Water Well Contractor's Signature [Signature] Completion Date
 License No. 1232

SURFACE CASING, CASING AND LINER MATERIAL:

Types	Diam. (In.)	From (Ft.)	To (Ft.)
PVC	2	-4	+2.5
PVC Screen	2	-21	-4
Neat Cement: No. of Bags			
hole plug	1	-3	-2
sand	9	-21	-3

IRON: ppm SULFATES: ppm CHLORIDES: ppm
 FINISH: Screen: 17 (Ft.) Open Hole: (Ft.)

WELL LOCATION

 % % % of Section 21

Township 30 (N-S) Range 18 (E-W) Locate in Section

Latitude Deg. Min. Sec. N } Optional may be required
 Longitude W }

DRILL METHOD

☐ Rotary ☐ Cable Tool ☐ Jet ☒ Auger Other
 Measured Static Water Level + Ft.
 Measured Pumping Water Level + Ft.
 After Hours At G.P.M.
 Measuring Pt. (Describe) top of casing
 Which is 2.5 Ft. ☒ Above ☐ Below Land Surface

Depth (Ft.)	Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
From To	
0 .5	top soil and vegetation
.5 5	sand, fine to very fine, quartz, gray to dark gray
5 10	sand, quartz, fine to silt, clay 40-50%, gray to very dark gray, organic (decay vegetation) material
10 15	sand, quartz, fine to silt, clay 30%, abundant shell fragments 5mm, abundant heavies
15 17	sand, quartz, medium to very fine, silty, clay 50% glauconitic, gray green to blue green scattered shell fragments (med. gr.)
17	termination

Driller's Name Bobby Tinsley

Form No. 25-18-5/83

DRILL METHOD

☐ Rotary ☐ Cable Tool ☐ Jet ☒ Auger Other
 Measured Static Water Level + Ft.
 Measured Pumping Water Level + Ft.
 After Hours At G.P.M.
 Measuring Pt. (Describe) top of casing
 Which is 2.5 Ft. ☒ Above ☐ Below Land Surface

Depth (Ft.)	Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
From To	
0 .5	topsoil and vegetation
.5 4	sand, quartz, fine to very fine, gray, plant material
4 4.5	sand, quartz, fine to very fine, brown, calcite cement, few shell fragments
4.5 12	sand, quartz, fine to silt, clay 5-10%, gray to brown
12 15	sand, quartz, fine to very fine, clay 50-60%, gray blue
15 17	sand, quartz, fine to very fine, silty, clay 60% scattered shell fragments and quartz pebbles, abundant scattered heavy mins., very calcareous clay
17	termination

Driller's Name Bobby Tinsley

WELL COMPLETION REPORT

Owner's Name Engineering-Science
 Permit Number: 420602-11 MD13-2B
X 9-23-86
 Water Well Contractor's Signature Completion Date
 License No. 1272

**SURFACE CASING, CASING
AND LINER MATERIAL:**

Types	Diam. (In.)	From (Ft.)	To (Ft.)
PVC	2	-5.2	+2.5
PVC Screen	2	-20	-5.2
Neat Cement: No. of Bags		From (Ft.)	To (Ft.)
Cemnet	2	-2	+ .3
Hole plug	.5	-2.5	-2

IRON: ppm SULFATES: ppm CHLORIDES: ppm
FINISH: Screen: 14.80 (Ft.) Open Hole: (Ft.)

WELL LOCATION

____ % ____ % ____ % of Section 22

30 Township (N-S) 18 Range (E-W)

Latitude N } Optional
Deg. Min. Sec. may be
Longitude W } required

Please complete in black ink or type

WELL COMPLETION REPORT

Engineering-Science	
Owner's Name	
Permit Number	42060Y-14 MD17-3
X	9/22/86
Water Well Contractor's Signature	Completion Date
License No.	1752

**SURFACE CASING, CASING
AND LINER MATERIAL:**

Type	Diam. (In.)	From (Ft.)	To (Ft.)
PVC	2	+2.5	-5.5
PVC Screen	2	-20.5	-5.5
Next Cement	No. of Bags	From (Ft.)	To (Ft.)
Holeplug	5	-4	-3
sand	7	-20.5	-4

IRON: _____ ppm SULFATES: _____ ppm CHLORIDES: _____ ppm
FINISH: Screen: 15 (Ft.) Open Hole: _____ (Ft.)

WELL LOCATION

____ % ____ % ____ % of Section 21

30
S
13
E
 Township (N-S) Range (E-W)

Latitude	<input type="text"/>	<input type="text"/>	<input type="text"/>	N	Optional may be required
	Deg.	Min.	Sec.		
Longitude	<input type="text"/>	<input type="text"/>	<input type="text"/>	W	

DRILL METHOD

[] Rotary [] Cable Tool [] Jet [X] Auger Other _____
 Measured Static Water Level _____ + _____ Ft
 Measured Pumping Water Level _____ + _____ Ft
 After _____ Hours At _____ G.P.M.
 Measuring Pt. (Describe): top of casing
 Which is 2.5 Ft. [X] Above [] Below Land Surface

[illegible]

Driver's Name

Form No 25-18.5/83

DRILL METHOD

☐ Rotary ☐ Cable Tool ☐ Jet ☒ Auger Other _____
 Measured Static Water Level _____ + _____ Ft.
 Measured Pumping Water Level _____ + _____ Ft.
 After _____ Hours At _____ G.P.M.
 Measuring Pt. (Describe): top of casing
 Which is 2.5 Ft. ☒ Above ☐ Below Land Surface

[illegible]

Driller's Name Bobby Tinsley

WELL COMPLETION REPORT

WELL COMPLETION REPORT

WELL CONTRACTORS, INC.
Owner's Name Engineering-Science
Permit Number 420602711 MD13-2A
X W. Ziegler 9/23/86
Water Well Contractor's Signature Completion Date
License No. 1232

**SURFACE CASING, CASING
AND LINER MATERIAL:**

Types	Diam. (In.)	From (Ft.)	To (Ft.)
Net Cement: No. of Bags		From (Ft.)	To (Ft.)

IRON: _____ ppm SULFATES: _____ ppm CHLORIDES: _____ ppm
FINISH: Screen: _____ (Ft.) Open Hole: _____ (Ft.)

WELL LOCATION

____ % ____ % ____ % of Section 22

Township (N-S) Range (E-W) Locate in Section

Latitude N } Optional may be required

Longitude W }

DRILL METHOD

| Rotary | Cable Tool | Jet | Auger Other _____
 Measured Static Water Level _____ + _____ Ft.
 Measured Pumping Water Level _____ + _____ Ft.
 After _____ Hours At _____ G.P.M.
 Measuring Pt. (Describe): _____
 Which is _____ Ft. | Above | Below Land Surface

Depth (Ft.)		Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary
From	To	
0	.4	top soil, sandy, black quartz, fine to very fine vegetation and organic material
.4	10	sand, fine to very fine, XXXXX gray to black, rich in organic material toward top
10	22	sand, quartz, fine to very fine silty, slightly clay, white to tan, increasing clay toward bottom
22		clay ~50%, sand, quartz, fine to silt, limely fragments at TD of 22'
22		termination
note: hammer fell 17' to 22' with no resistance filled hole with benotite		

Driller's Name _____

WELL COMPLETION REPORT

OWNER'S NAME: Engineering-Science

PERMIT NUMBER 420602-11

MD13-2A

[illegible]

Owner's Name		
Permit Number:	420599-14	MD58-5
X	<i>[Signature]</i>	9-24-86
Water Well Contractor's Signature		Completion Date
License No.	1232	

**SURFACE CASING, CASING
AND LINER MATERIAL:**

Types	Diam. (In.)	From (Ft.)	To (Ft.)
PVC	2	-4	+2.5
PVC Screen	2	-14	-4
Next Cement	No. of Bags	From (Ft.)	To (Ft.)
Hole plug	1	-3	-2
sand	5	-14	-3

IRON: _____ ppm SULFATES: _____ ppm CHLORIDES: _____ ppm
FINISH: Screen: 10 (Ft.) Open Hole: _____ (Ft.)

WELL LOCATION

____ % ____ % ____ % of Section 28

30	5	18	E		
Township	(N-S)	Range	(E-W)	Locate in Section	
Latitude				N } Optional may be required	
	Deg.	Min.	Sec.		
Longitude				W }	

Please complete in black ink or type

WELL COMPLETION REPORT

Owner's Name Engineering-Science
 Permit Number 420620-14 MD58-6
 X 02/23/2014 9-24-86
 Water Well Contractor's Signature Completion Date
 License No. 0232

**SURFACE CASING, CASING
AND LINER MATERIAL:**

Types	Diam. (In.)	From (Ft.)	To (Ft.)
PVC	2	-4.1	+2.5
PVC Screen	2	-10	-4.1
Neat Cement	to of Bags	From (Ft.)	To (Ft.)
Hole plug	1	-3	-2
Sand	4.25	-10.1	-3

IRON: _____ ppm SULFATES: _____ ppm CHLORIDES: _____ ppm
FINISH: Screen: 5.90 (Ft.) Open Hole: _____ (Ft.)

WELL LOCATION

____ % ____ % ____ % of Section 28

Township (N-S) Range (E-W)

Latitude N

Longitude Deg. Min. Sec. W

Optional may be required

DRILL METHOD

| Rotary | Cable Tool | Jet | ☒ Auger | Other _____
 Measured Static Water Level _____ + _____ = _____ Ft.
 Measured Pumping Water Level _____ + _____ = _____ Ft.
 After _____ Hours At _____ G.P.M.
 Measuring Pt. (Describe): top of casing
 Which is 2.5 Ft. ☒ Above | Below Land Surface

[illegible]

Driver's Name Bobby Tinsley

Form No. 25 10-5/83

DRILL METHOD

() Rotary () Cable Tool () Jet (x) Auger Other _____
 Measured Static Water Level _____ + _____ = _____ Ft.
 Measured Pumping Water Level _____ + _____ = _____ Ft.
 After _____ Hours At _____ G.P.M.
 Measuring Pt. (Describe): top of casing
 Which is 2.5 Ft. (x) Above () Below Land Surface

Depth (Ft.)		Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary
From	To	
0	.4	top soil
.4	5	sand, quartz, fine to very fine, white to black, organic (vegetation) rich in dark zone
5	8	sand, quartz, fine to very fine, choc. brown, rich in organic (vegetation) material, decaying plant
8	10	clay, blue-green, stiff, slightly sandy zones, plant & shell fragments
10		termination

Driller's Name Bobby Tinsley

WELL COMPLETION REPORT

License No. 1232

**SURFACE CASING, CASING
AND LINER MATERIAL:**

Types	Diam. (In.)	From (Ft.)	To (Ft.)
PVC	2	-4	+2.5
PVC	2	-14	-4
Neat Cement: No. of Bags		From (Ft.)	To (Ft.)
Holeplug	1	-3	-2
sand	5.5	-14	-3

FINISH: Screen: 10 (Ft.) Open Hole: _____ (Ft.)

WELL LOCATION

____ % ____ % ____ % of Section 27

30
S
18
E
 Township (N-S) Range (E-W)

Latitude

--	--	--	--

Cartridge

Longitude

--	--

--	--

--	--

Locate in Section

7

Optional

may be required

DRILL METHOD

☐ Rotary ☐ Cable Tool ☐ Jet ☒ Auger Other _____

Measured Static Water Level _____ + _____ Ft

Measured Pumping Water Level _____ +

After _____ Hours At _____ G.P.M.

Measuring Pt. (Describe): top of casing

Measuring Pt. (Describe): Top of casing
Which is: 2-5 Ft. ☒ Above ☐ Below Land Surface

What is 4.4 Ft. [X] Above [] Below Land Surface

Depth (Ft.)		Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
From	To	
0	.5	topsoil and vegetation
.5	1	fill material-sand fine to very fine, limestone fragments ≤6mm diameter
1	5	sand, quartz, fine to very fine, gray to black, organic material (decaying vegetation)
5	10	sand, quartz, fine to very fine, brown plant material
10	14	sand, quartz, fine to silt, clay ~5-10%, tan
14	15	clay, sandy, gray-green ~1' thick
15	23.5	sand, quartz, fine to very fine clay ~50%, gray-green limestone fragments

Driller's Name	Bobby Tinslev
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WELL COMPLETION REPORT

OWNER'S NAME: Engineering-Science

PERMIT NUMBER 420619-11 MDB-3

[illegible]

WELL COMPLETION REPORT

WELL COMPLETION REPORT

Owner's Name Engineering Science
 Permit Number: 420624-14 MD23-D2
 X W. J. J. Jr. 9/30/86
 Water Well Contractor's Signature Completion Date
 License No. 1232

SURFACE CASING, CASING AND LINER MATERIAL:

Types	Diam. (In.)	From (Ft.)	To (Ft.)
PVC	8	-30.9	0
PVC	2	-70	+2.5
Screen	2	-90	-70
Next Cement: No. of Bags			
cement	11	-30.9	0
Cement	7	-26	0

IRON: ___ ppm SULFATES: ___ ppm CHLORIDES: ___ ppm
 FINISH: Screen: ___ (Ft.) Open Hole: ___ (Ft.)

WELL LOCATION

___ X ___ X of Section 21

30 S 18 E
 Township (N-S) Range (E-W) Locate in Section
 Latitude N } Optional
 Deg Min. Sec. may be
 Longitude W }

DRILL METHOD

☒ Rotary ☐ Cable Tool ☐ Jet ☐ Auger Other ___
 Measured Static Water Level ___ Ft.
 Measured Pumping Water Level ___ Ft.
 After ___ Hours At ___ G.P.M.
 Measuring Pt. (Describe): top of casing
 Which is 2.5 Ft. ☒ Above ☐ Below Land Surface

Depth (Ft.)		Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
From	To	
0	2	sand, quartz, fine to very fine, gray to dark gray, plant material
2	15	sand, quartz, fine to silt, clay 5-10%, brown to gray
15	19	sand, quartz, fine to very fine, clay 5-10%, black, decaying plant odor
19	25	clay, gray to dark gray, 40% shell fragments, 40% clay, 20% sand, fine to medium
25	29	sand, quartz, medium to very fine, scattered heavies & shell fragments slightly clayey
29	35	clay, blue-green, very stiff, slightly sandy

Driller's Name Bobby Tinsley

WELL COMPLETION REPORT

OWNER'S NAME Engineering Science

PERMIT NUMBER 420624-14

MD23-D2

Depth		FORMATION	Depth		FORMATION
From	To		From	To	
35	45	Clay, blue-green, sand 40%, medium to very fine, scattered silica cement			
45	50	sand, quartz, medium to very fine, clay 40%, scattered shell fragments, blue-gray			
50	60	clay, cemented, very hard and brittle, blue-green, laminated			
60	75	limey silty sands, some scattered caco, cement, tan to buff			
75	88	limestone, weathered, silty, slightly sandy, sparse cherty fragments			
88		termination			

WELL COMPLETION REPORT

Owner's Name Engineering-Science
 Permit Number: 420623-14 MD23-D3
 X [Signature] 9-30-86
 Water Well Contractor's Signature Completion Date
 License No. 1232

SURFACE CASING, CASING AND LINER MATERIAL:

Types	Diam. (In.)	From (Ft.)	To (Ft.)
PVC	8	-16.9	0
PVC	2	-42	+2.5
PVC Screen	2	-57	-42
Next Cement: No. of Bags			
Cement	7	-16.9	0
Cement	5	-13	0

IRON: ppm SULFATES: ppm CHLORIDES: ppm
 FINISH: Screen: 15 (Ft.) Open Hole: (Ft.)

WELL LOCATION

 % % of Section 21

<u>30</u>	<u>S</u>	<u>18</u>	<u>E</u>
Township	(N-S)	Range	(E-W)
Latitude	<u> </u>	<u> </u>	<u> </u>
Longitude	<u> </u>	<u> </u>	<u> </u>

Optional may be required

DRILL METHOD

☒ Rotary ☐ Cable Tool ☐ Jet ☐ Auger Other
 Measured Static Water Level + Ft.
 Measured Pumping Water Level + Ft.
 After Hours At G.P.M.
 Measuring Pt. (Describe): top of casing
 Which is 2.5 Ft. ☒ Above ☐ Below Land Surface

Depth (Ft.)	From	To	Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
0	5		sand, quartz, fine to very fine, light gray to black, plant material
5	10		sand, quartz, fine to silt, silty, clay ~20-30%, gray scattered plant material
10	15		sand, quartz, fine to very fine, clay ~5%, shell fragments up to 10mm diameter, few scattered rounded qtz. pebbles, scattered heavies, very calcareous
15	20		clay, blue-green, very stiff, scatter. brown streaks
20	35		silty clay, sands 10-40%, Gray to gray-blue, stiff
35	40		limy clay, sandy, quartz, fine to very fine, ~40%, scattered limestone

Driller's Name Bobby Tinsley

WELL COMPLETION REPORT

OWNER'S NAME: Engineering-Science

PERMIT NUMBER 420623-14 MD23-D3

Depth From	To	FORMATION	Depth From	To	FORMATION
		fragments, buff to light gray			
40	45	weathered limestone, cream to white, fragmented			
45	50	Limestone, silty, sand ~30%, fine to very fine, clay 10-20%, large limestone fragments up 15 mm longest axis			
50	55	Limestone, sand 30-40%, fine to very fine, clay 10-20%, limestone fragments < 1mm to 10mm, cream to light gray			
55	57	silty limey sand, sand ~60%, clay ~20%, limestone fragments < 1mm to < 3mm longest axis, light gray to buff			
57		termination			

WELL COMPLETION REPORT

Owner's Name Engineering-Science
 Permit Number: 420620-17 MDB-4
 X W. J. J. J. 9/23/86
 Water Well Contractor's Signature Completion Date
 License No. 1232

SURFACE CASING, CASING AND LINER MATERIAL:

Types	Diam. (In.)	From (Ft.)	To (Ft.)
PVC	2	-5	+2.5
PVC Screen	2	-15	-5
Neat Cement: No. of Bags		From (Ft.)	To (Ft.)
Hole plug	1	-4	-3
sand	6	-15	-4

IRON: ___ ppm SULFATES: ___ ppm CHLORIDES: ___ ppm
 FINISH: Screen: 10 (Ft.) Open Hole: ___ (Ft.)

WELL LOCATION

___ % ___ % of Section 27

<u>30</u>	<u>S</u>	<u>18</u>	<u>E</u>
Township (N-S)	Range	(E-W)	
Latitude	Deg.	Min.	Sec.
Longitude			

Optional may be required

Please complete in black ink or type

WELL COMPLETION REPORT

Owner's Name Engineering-Science
 Permit Number: 420621-17 MD3-6
 X W. J. J. J. 9/24/86
 Water Well Contractor's Signature Completion Date
 License No. 1252

SURFACE CASING, CASING AND LINER MATERIAL:

Types	Diam. (In.)	From (Ft.)	To (Ft.)
PVC	2	-4	+2.5
PVC	2	-14	-4
Neat Cement: No. of Bags		From (Ft.)	To (Ft.)
holeplug	.5	-2.8	-1.8
sand	2.5	-14	-2.8

IRON: ___ ppm SULFATES: ___ ppm CHLORIDES: ___ ppm
 FINISH: Screen: 10 (Ft.) Open Hole: ___ (Ft.)

WELL LOCATION

___ % ___ % of Section 27

<u>30</u>	<u>S</u>	<u>18</u>	<u>E</u>
Township (N-S)	Range	(E-W)	
Latitude	Deg.	Min.	Sec.
Longitude			

Optional may be required

DRILL METHOD

☐ Rotary ☐ Cable Tool ☒ Jet ☒ Auger Other ___
 Measured Static Water Level ___ + ___ Ft.
 Measured Pumping Water Level ___ + ___ Ft.
 After ___ Hours At ___ G.P.M.
 Measuring Pt. (Describe): top of casing
 Which is 2.5 Ft. ☒ Above ☐ Below Land Surface

Depth (Ft.)		Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
From	To	
0	.3	top soil and vegetation
.3	.5	fill material-sand, quartz, fine to very fine, limestone fragments <6mm diameter, brown to tan
.5	5	sand, quartz, fine to very fine, gray to brown
5	10	sand, quartz, fine to very fine, gray plant material
10	16	sand, quartz, fine to very fine, white to light gray sparse scatter heavies, sparse plant material, coarsens at 16' with scattered limestone fragments <5mm diameter
16	17	clay, gray to gray-green, sand, ~40% quartz fine to silt
17		termination

Driller's Name Bobby Tinsley

Form No. 25-18-5/83

DRILL METHOD

☐ Rotary ☐ Cable Tool ☒ Jet ☒ Auger Other ___
 Measured Static Water Level ___ + ___ Ft.
 Measured Pumping Water Level ___ + ___ Ft.
 After ___ Hours At ___ G.P.M.
 Measuring Pt. (Describe): top of casing
 Which is 2.5 Ft. ☒ Above ☐ Below Land Surface

Depth (Ft.)		Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
From	To	
0	.5	topsoil, sandy, vegetation, gray to black
.5	5	sand, quartz, fine to very fi gray to black, rich in organi (vegetation decay) material
5	14	sand, quartz, fine to very fi chocolate brown rich in organic (vegetation) material
14	14.5	clay, sandy, fine to silt brown
14.5	15	limestone, weathered, clayey, white, fragmented <1" diameter
15		termination

Driller's Name Bobby Tinsley

WELL COMPLETION REPORT

Owner's Name Engineering-Science
 Permit Number 420617-11 MDB-1
 X [Signature] 9-23-86
 Water Well Contractor's Signature Completion Date
 License No. 1232

SURFACE CASING, CASING AND LINER MATERIAL:

Types	Diam. (In.)	From (Ft.)	To (Ft.)
PVC	2	-4	+2.6
PVC Screen	2	-17	-4
Neat Cement: No. of Bags		From (Ft.)	To (Ft.)
Hole plug	1	-3	-2
Sand	6.5	-17	-3

IRON: _____ ppm SULFATES: _____ ppm CHLORIDES: _____ ppm
 FINISH: Screen 13 (Ft.) Open Hole: _____ (Ft.)

WELL LOCATION

____ % ____ % ____ % of Section 27

<u>30</u>	<u>S</u>	<u>18</u>	<u>E</u>
Township (N-S)	Range	(E-W)	
Latitude	____	____	____
Longitude	____	____	____

Optional may be required

Please complete in black ink or type

WELL COMPLETION REPORT

Owner's Name Engineering Science
 Permit Number: 420618-11 MDB-2
 X [Signature] 9/23/86
 Water Well Contractor's Signature Completion Date
 License No. 1232

SURFACE CASING, CASING AND LINER MATERIAL:

Types	Diam. (In.)	From (Ft.)	To (Ft.)
PVC	2	-4	+2.5
PVC	2	-14	-4
Neat Cement No. of Bags		From (Ft.)	To (Ft.)
Holeplug	1	-3.2	-2.2
sand	4.5	-14.	-3.2

IRON: _____ ppm SULFATES: _____ ppm CHLORIDES: _____ ppm
 FINISH: Screen: 10 (Ft.) Open Hole: _____ (Ft.)

WELL LOCATION

____ % ____ % ____ % of Section 27

<u>30</u>	<u>S</u>	<u>18</u>	<u>E</u>
Township (N-S)	Range	(E-W)	
Latitude	____	____	____
Longitude	____	____	____

Optional may be required

DRILL METHOD

☐ Rotary ☐ Cable Tool ☐ Jet ☒ Auger Other _____
 Measured Static Water Level _____ + _____ Ft.
 Measured Pumping Water Level _____ + _____ Ft.
 After _____ Hours At _____ G.P.M.
 Measuring Pt. (Describe): Top of Casing
 Which is 2.6 Ft. ☒ Above ☐ Below Land Surface

Depth (Ft.)	From	To	Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
0	.5		top soil and vegetation
.5	3		fill material-sand, quartz, fine to gravel, white to gray limestone fra
3	10		sand, quartz, fine to very fine, brown, plant material
10	15		sand, quartz, fine to very fine, white to tan few scattered heavies
15	20		sand, quartz, medium to silt, clay, ~20%, gray limestone fragments at 16' (gravel size)
20	22		clay, gray-green, sand 30-40%, very fine to pebble, limestone fragments <5mm diameter
22			termination

Driller's Name Bobby Tinsley

Form No. 25 18-5/83

DRILL METHOD

☐ Rotary ☐ Cable Tool ☐ Jet ☒ Auger Other _____
 Measured Static Water Level _____ + _____ Ft.
 Measured Pumping Water Level _____ + _____ Ft.
 After _____ Hours At _____ G.P.M.
 Measuring Pt. (Describe): Top of casing
 Which is 2.5 Ft. ☒ Above ☐ Below Land Surface

Depth (Ft.)	From	To	Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
0	.4		topsoil and plant material
.4	10		sand, quartz, fine to very fine, brown to tan, plant material
10	14		sand, quartz, fine to silt, slightly clayey, white to tan
14	17		sand, quartz, fine to silt clay ~30-40%, gray to gray-green
17			termination

Driller's Name Bobby Tinsley

WELL COMPLETION REPORT

Permit Number: 436390-13

x W. H. H. H. 8-15-87
Water Well Contractor's Signature Completion Date

License No. 1232 MD B-5

**SURFACE CASING, CASING
AND LINER MATERIAL:**

Types	Diam. (In.)	From (Ft.)	To (Ft.)
PVC sch 40	2"	+2.5	-2.5
PVC (screen)sch 40	2"	-2.5	-12.5
Neat Cement: No. of Bags		From (Ft.)	To (Ft.)
Portland cement	5	-6"	+3
sand	20-30	5	-13.5
			-1.5

IRON: _____ ppm SULFATES: _____ ppm CHLORIDES: _____ ppm
FINISH: Screen: _____ (Ft.) Open Hole: _____ (Ft.)

WELL LOCATION

____ % ____ % ____ % of Section 21

Township

3	0
---	---

 (N-S) Range

1	8
---	---

 (E-W)

--	--

 Locate in Section

Latitude

--	--

--	--

--	--

 } Optional may be required

Longitude

--	--

 Deg.

--	--

 Min.

--	--

 Sec.

--	--

 } W

Please complete in black ink or type

WELL COMPLETION REPORT

Owner's Name U. S. GOVERNMENT MacDill A.F.B.

Permit Number: 4364391-13 MD DK 17-4

X W. H. Hinkle 4-14-87
Water Well Contractor's Signature Completion Date

License No. 1232

**SURFACE CASING, CASING
AND LINER MATERIAL:**

Types	Diam. (In.)	From (Ft.)	To (Ft.)
PVC sch 40	2"	+2.5'	-2.5'
PVC (screen)	-2"	-2.5'	-17.5'
Net Cement: No. of Bags		From (Ft.)	To (Ft.)
cement	.5	+3"	-6"

IRON: ___ ppm SULFATES: ___ ppm CHLORIDES: ___ ppm
FINISH: Screen: 15' (Ft.) Open Hole: 5' (Ft.)

WELL LOCATION

____ % ____ % ____ % of Section 21

Township	(N-S)	Range	(E-W)	Locate in Section
Latitude	Deg.	Min.	Sec.	N } Optional W } may be required
Longitude				

DRILL METHOD

☐ Rotary ☐ Cable Tool ☐ Jet ☒ Auger Other _____

Measured Static Water Level _____ + _____ = 4' 4" Fl

Measured Pumping Water Level _____ + _____ - D/a Ft

After _____ Hours At _____ G.P.M.

Measuring Pt. (Describe): top of casing

Which is 2.5 Ft. ☒ Above ☐ Below Land Surface

[illegible]

Driver's Name Tom Oberstar

Form No. 25-18.5/83

DRILL METHOD

☐ Rotary ☐ Cable Tool ☐ Jet ☒ Auger Other _____

Measured Static Water Level * 3.5' Ft.

Measured Pumping Water Level _____ + _____ · $\frac{n/a}{F_t}$

After _____ Hours At _____ G.P.M.

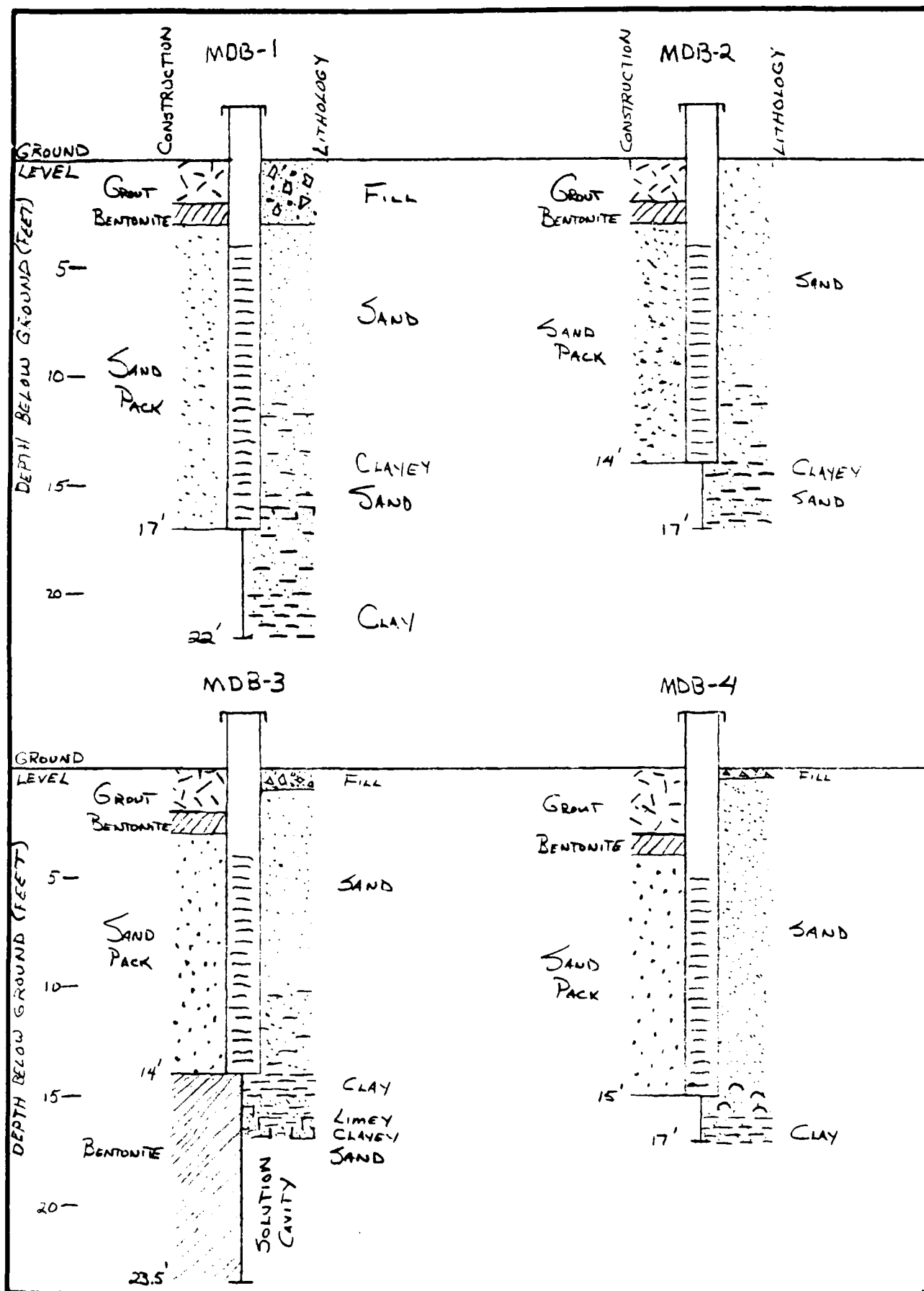
Measuring Pt. (Describe): top of casing

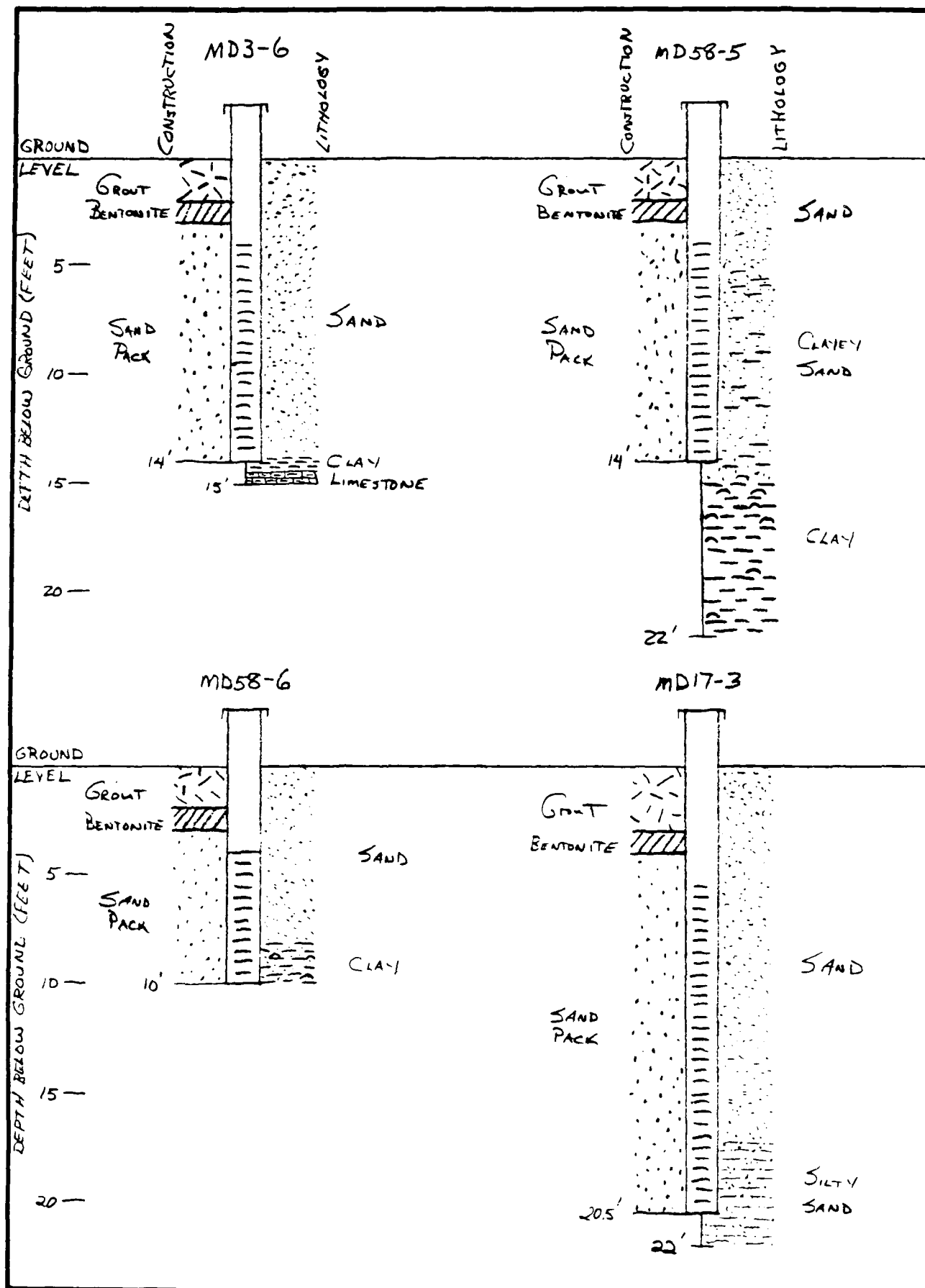
Which is 2.5' Ft. ☒ Above ☐ Below Land Surface

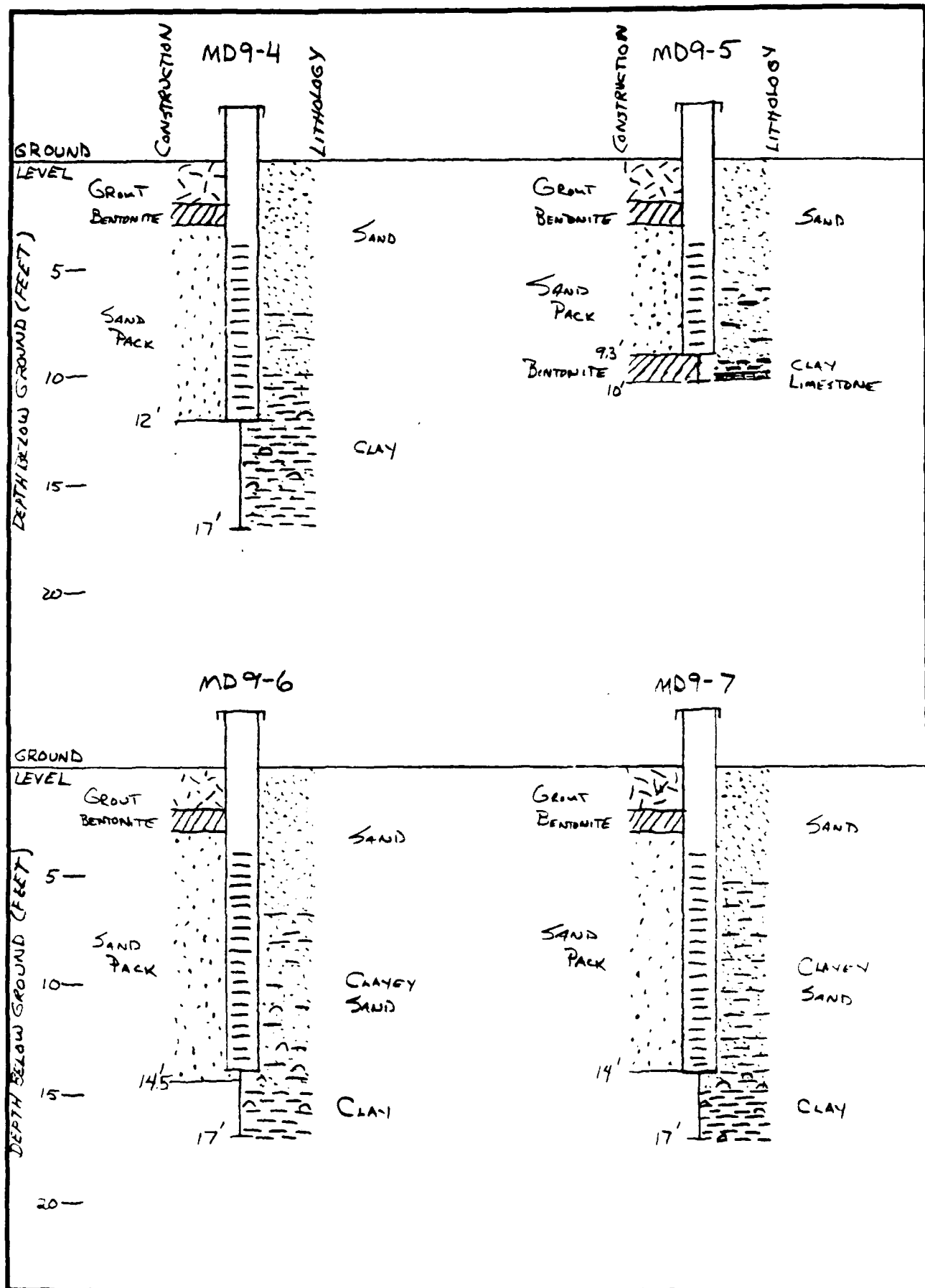
[illegible]

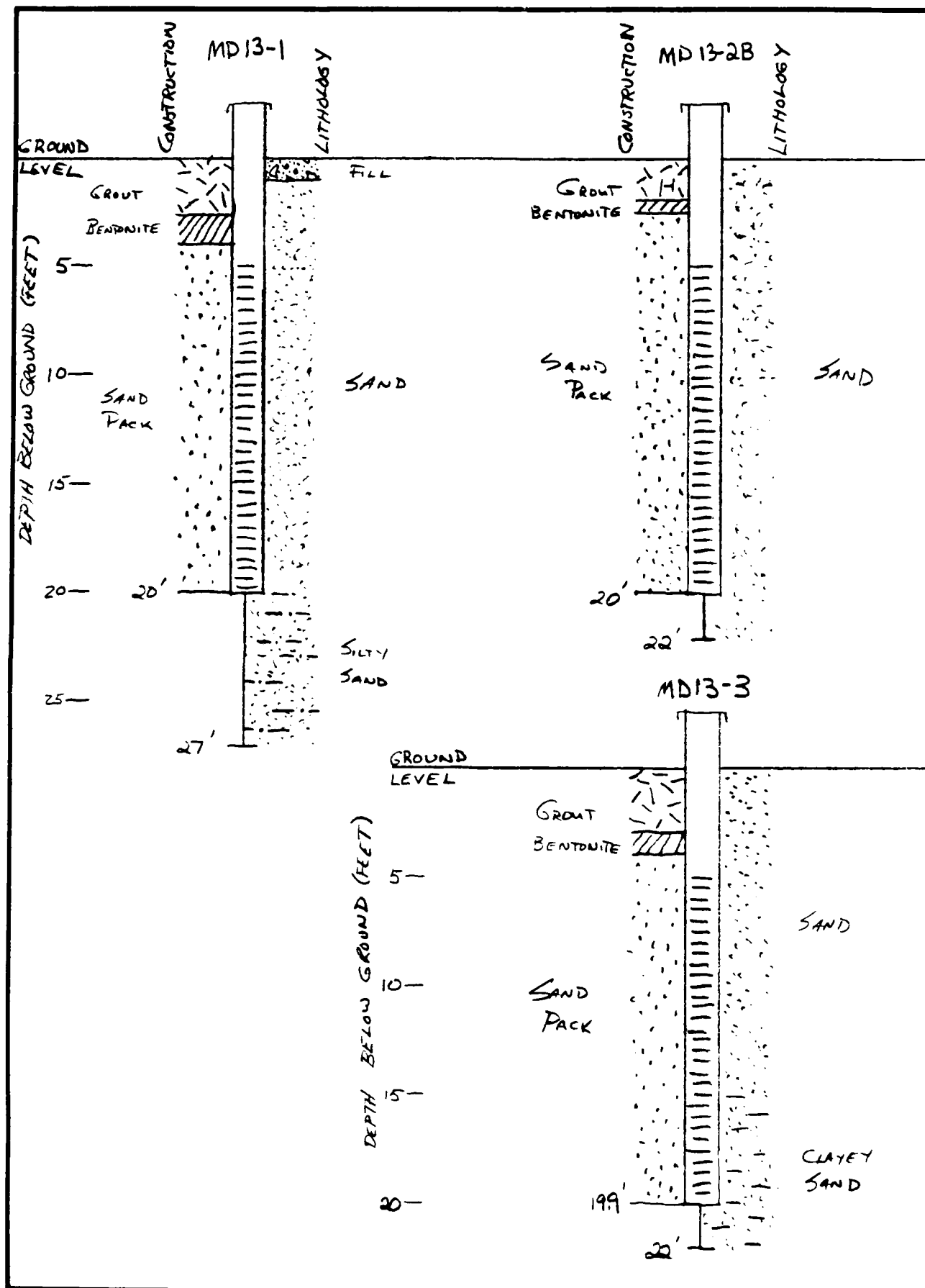
Driller's Name Tom Oberstar

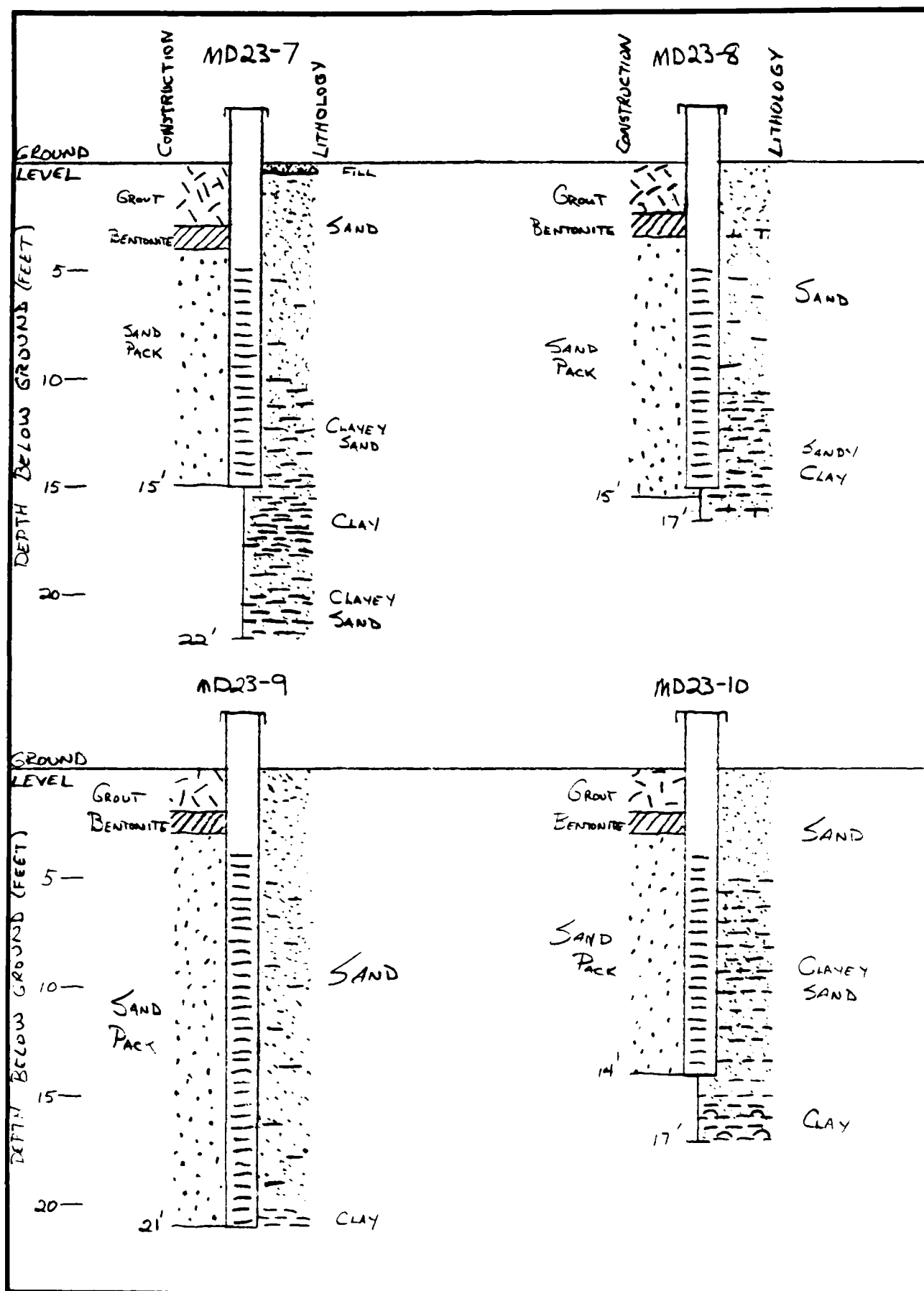
WELL CONSTRUCTION DIAGRAMS

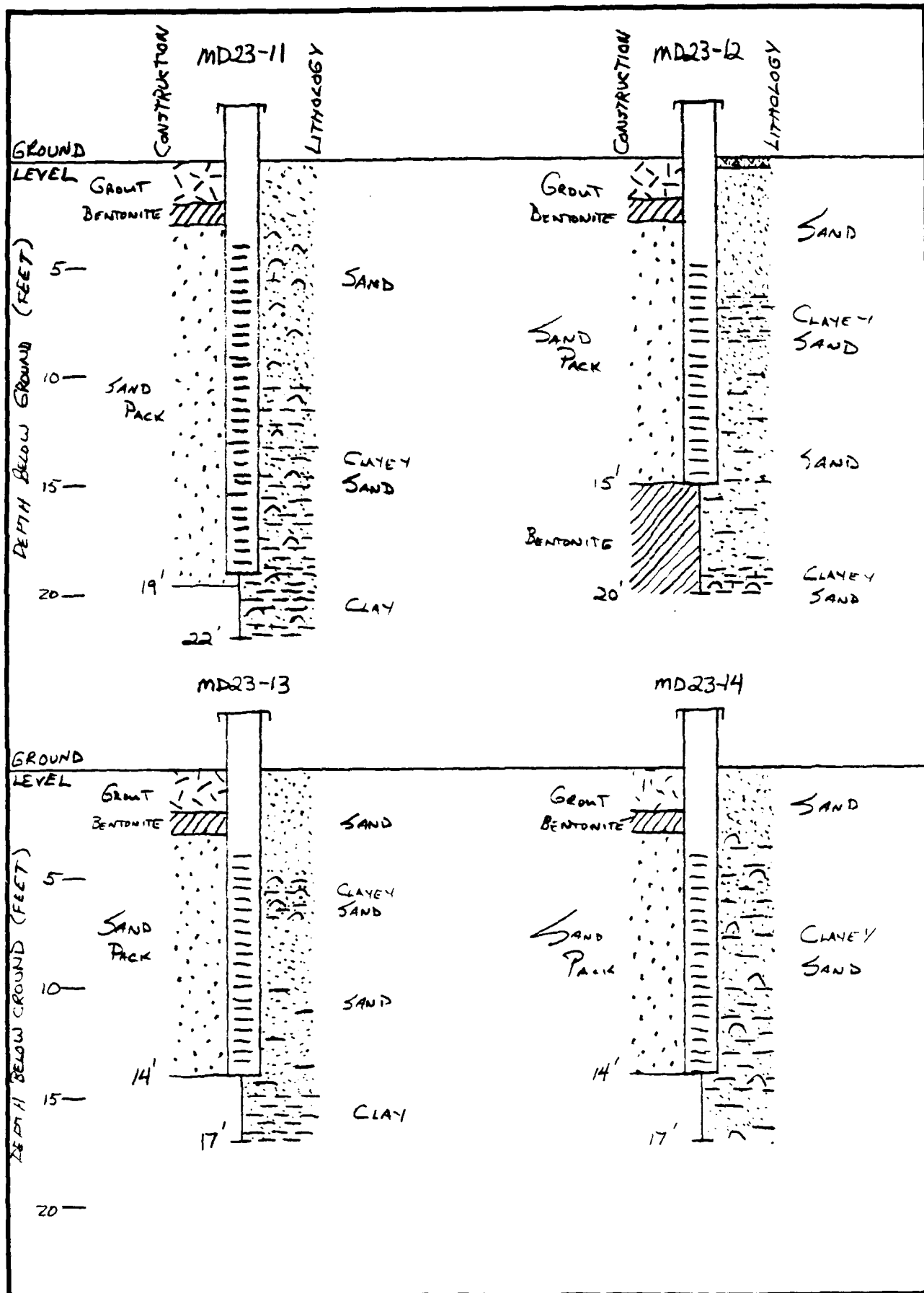


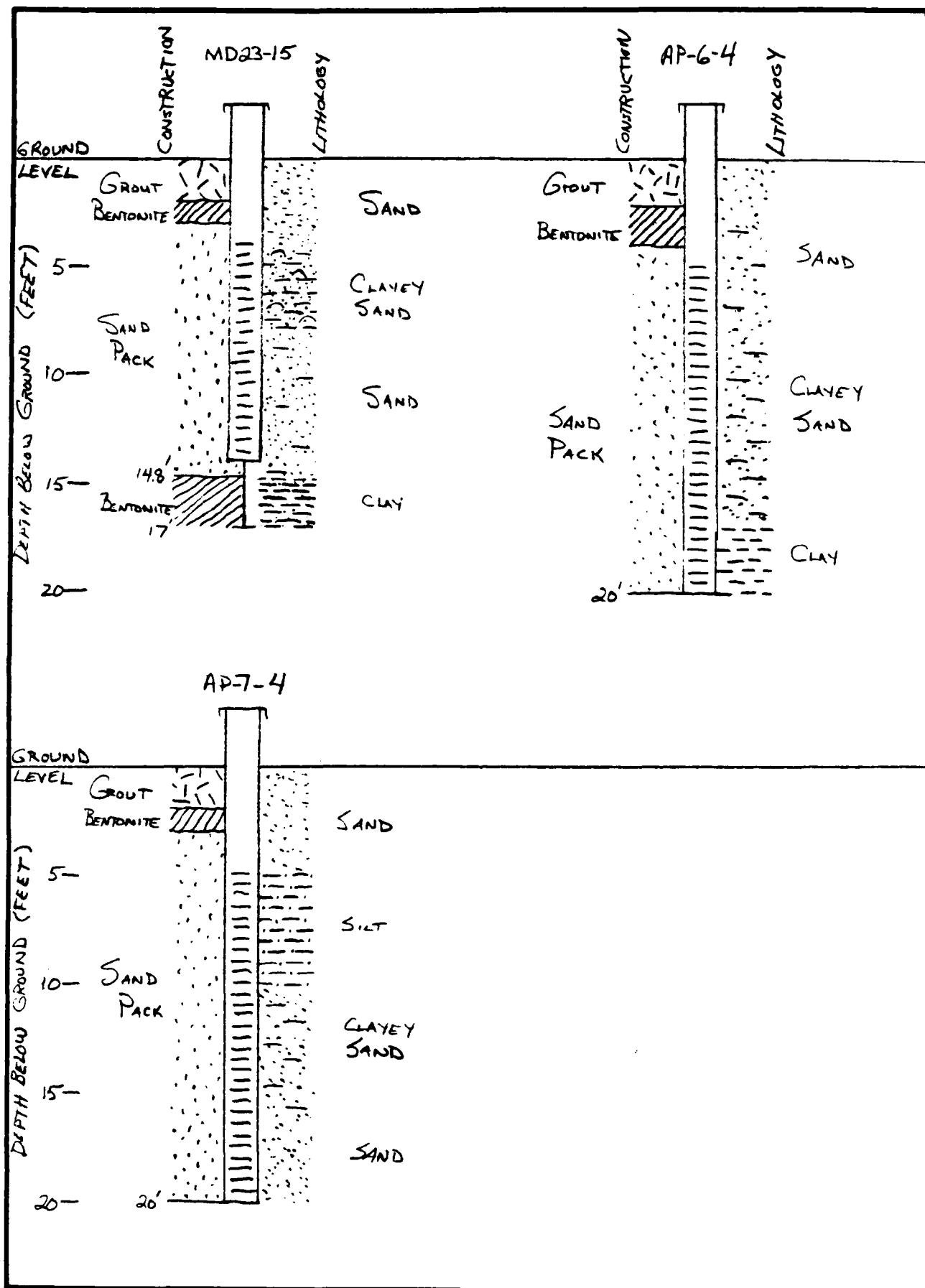


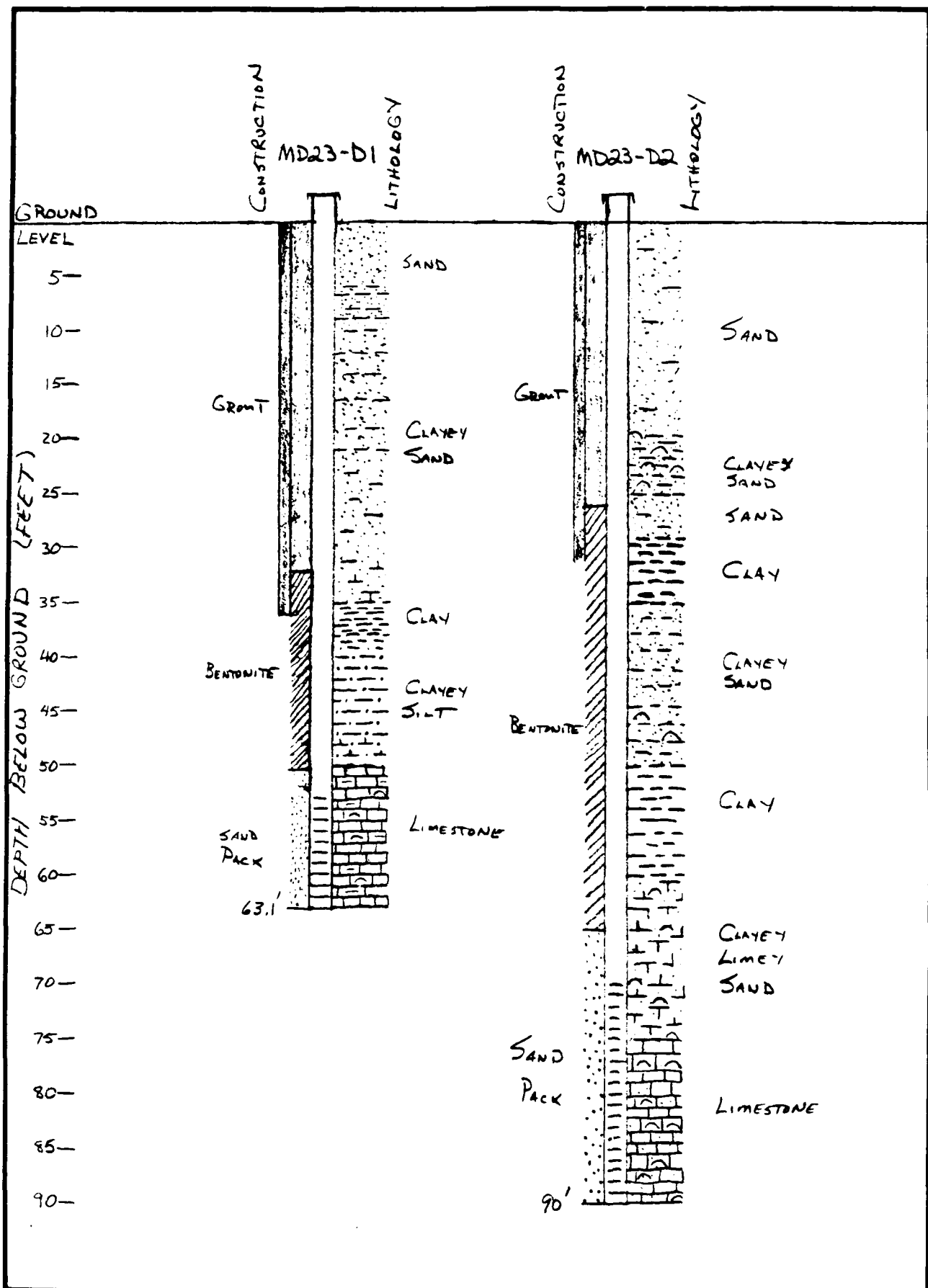


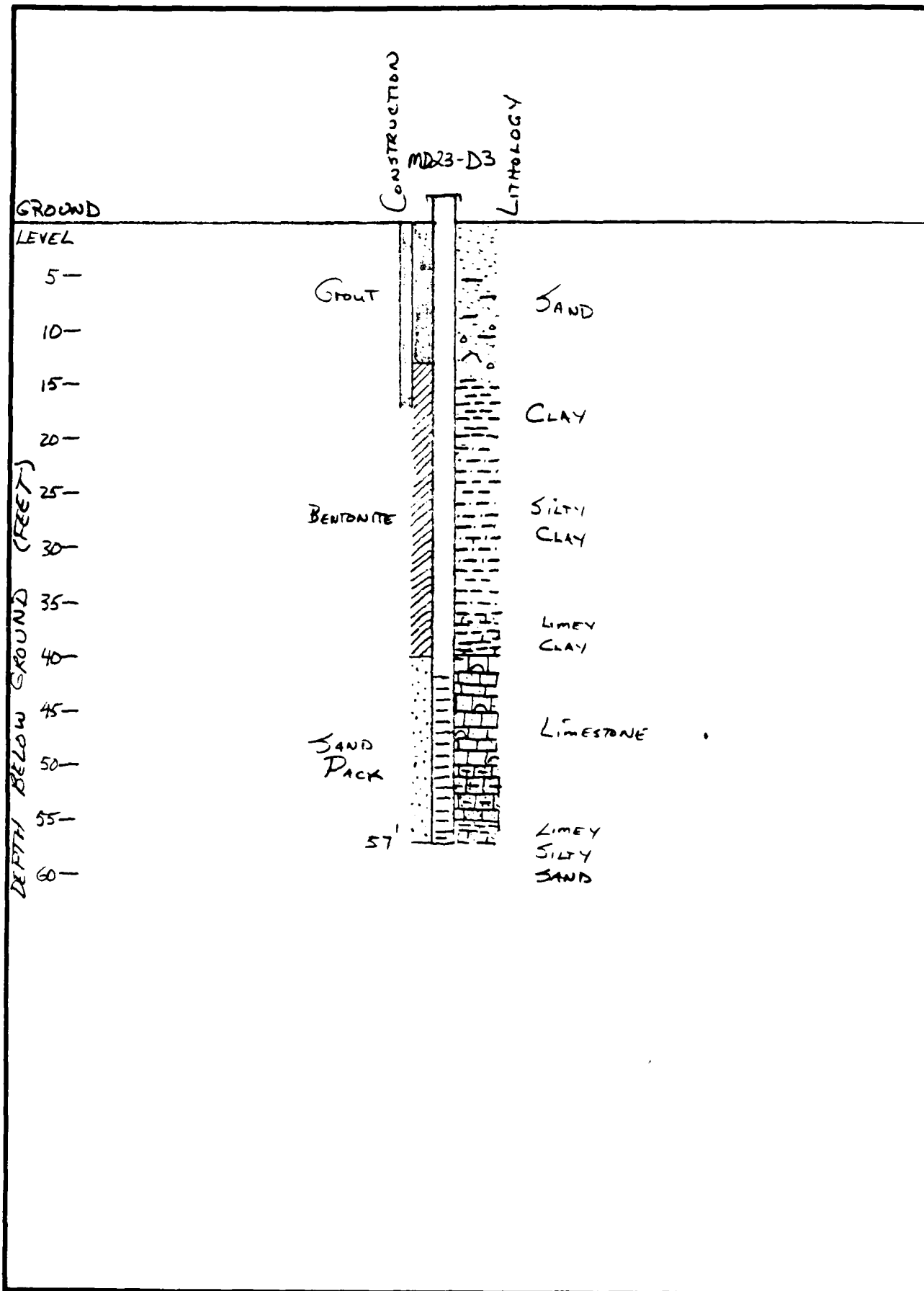










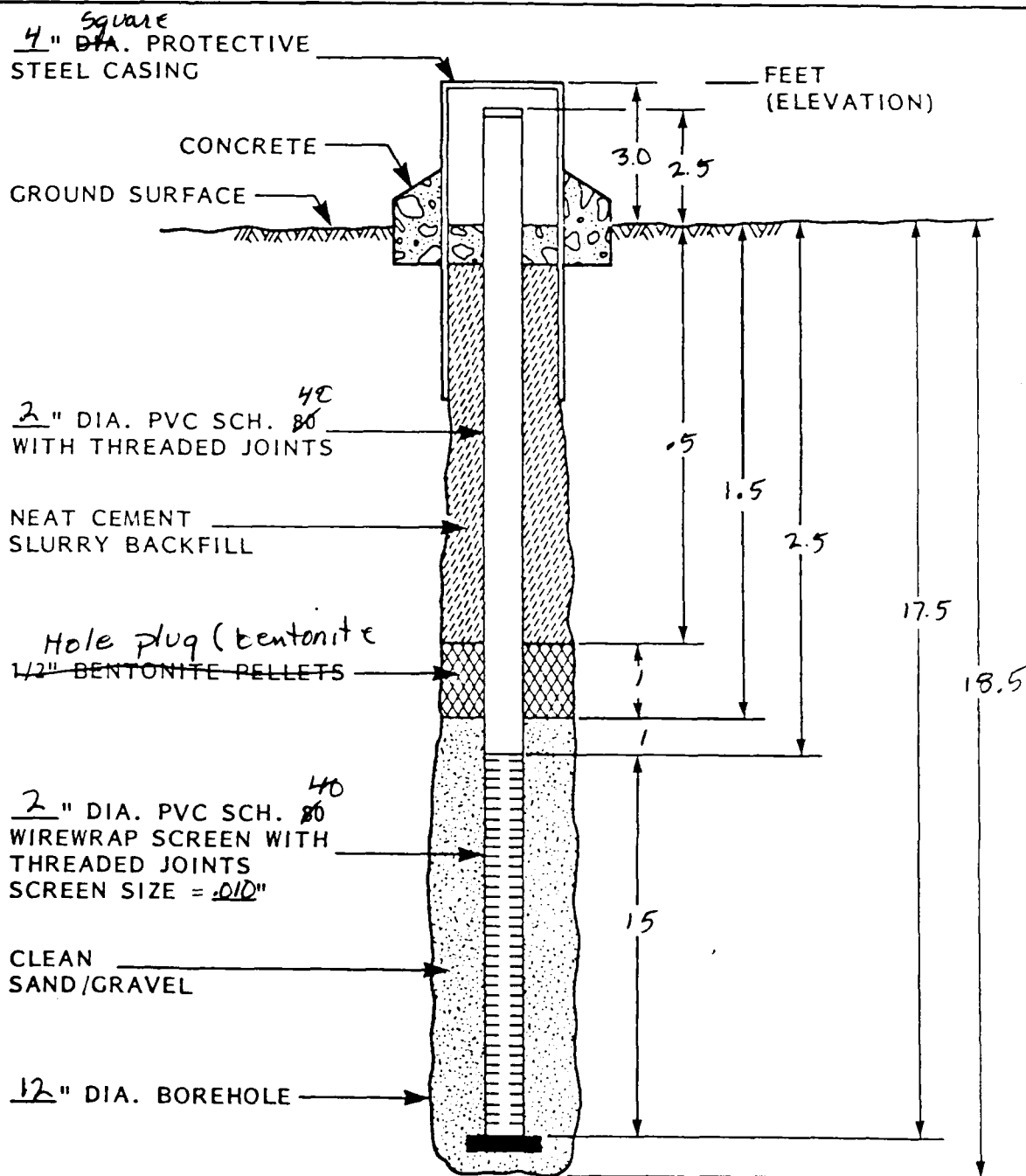


ENGINEERING-SCIENCE

MONITORING WELL COMPLETION

Project Name MacDill AFB
 Project Number AT001
 Well Number MW17-4
 Date Drilled 8-14-87
 Date Installed 8-14-87

Driller Diversified Drilling
 Drilling Method 12" HSA
 Development Method pumped
 Geologist/Engineer R.S. Bonner



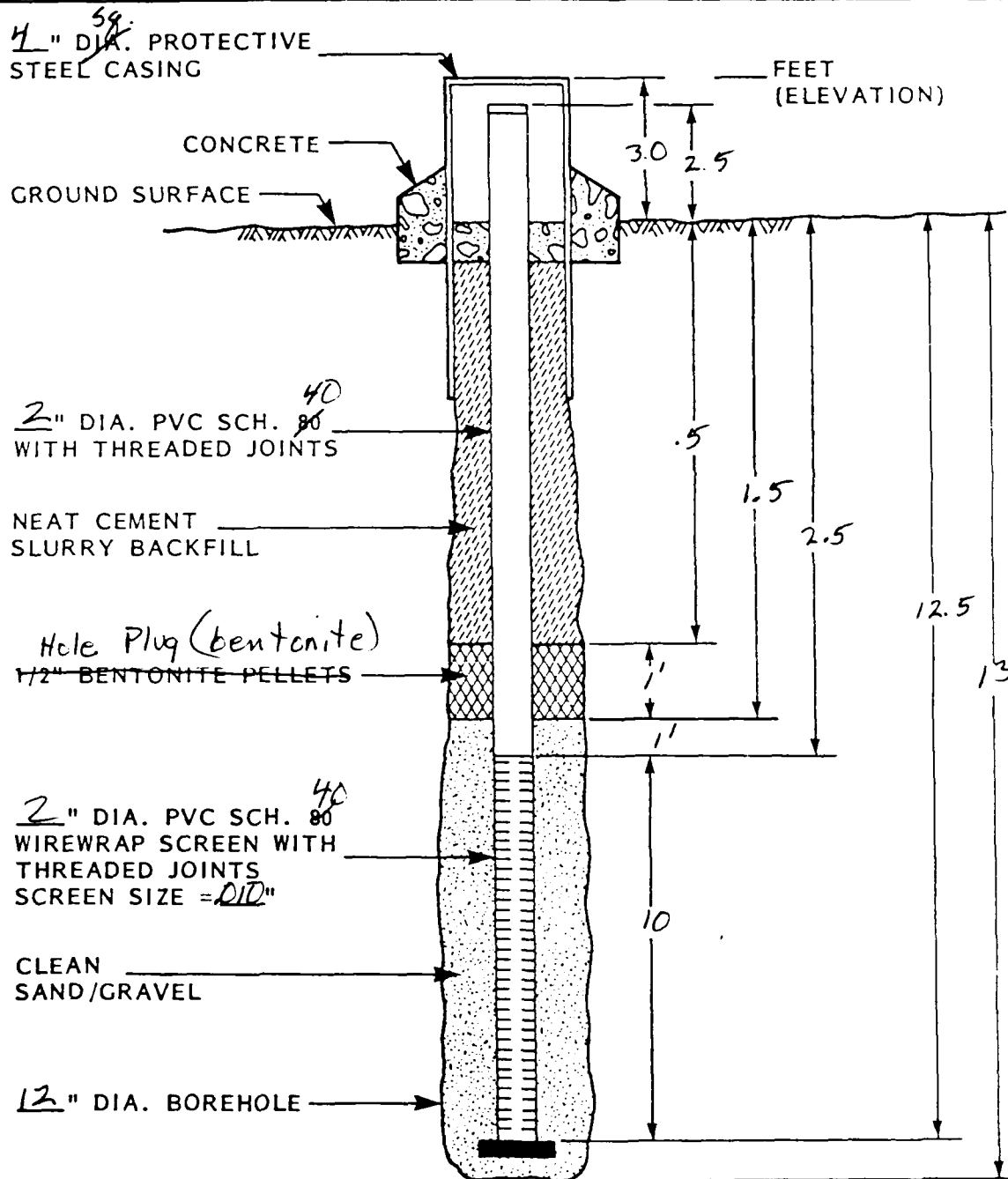
NOT TO SCALE 9 Bag Sand

ENGINEERING-SCIENCE

MONITORING WELL COMPLETION

Project Name MacDill AFB
 Project Number AT 001
 Well Number MW B-5
 Date Drilled 8-15-87
 Date Installed 8-15-87

Driller Diversified Drilling
 Drilling Method HSA 12"
 Development Method Pumping
 Geologist/Engineer R.S. Bonner



NOT TO SCALE 5 Bags Sand

APPENDIX E
AQUIFER TEST ANALYSIS

APPENDIX E

AQUIFER TEST ANALYSIS

INTRODUCTION

Within this appendix are presented the procedures, raw data, and results for the aquifer pumping test performed at Site No. 23 on MacDill AFB. The procedures and results are presented in Section E.1. Water level data are presented in Section E.2 and computations for drawdown and recovery analyses are presented in Section E.3.

E.1 AQUIFER TEST RESULTS

An aquifer pumping test was performed at Site No. 23 from 15 to 17 October, 1986. Well MD23-11, installed as a four-inch diameter well, was used as the pumping well. Well MD23-15 was installed as an observation well, approximately 30 feet from well MD23-11 (Figure E.1). Both wells were completed in the sandy sediments of the surficial aquifer. Well construction details for wells MD23-11 and MD23-15 are given in Table E.1. Figure E.2 is a geologic cross-section showing the relationship between the pumped well and the observation well.

A step-drawdown test was performed prior to the aquifer pumping test, and it indicated that the surficial aquifer could sustain approximately 4.5 gallons per minute (gpm) pumping rate without pumping the well dry. The pumped water was discharged to a drainage canal approximately 300 feet north of the pumped well.

Water levels in the pumped well and the observation well were measured prior to pumping and immediately before pumping. Water level declines were measured and noted during pumping and during recovery in both wells. Well MD23-11 was pumped for approximately 10 hours at a constant rate of approximately 4.5 gpm. Maximum water level decline was 9.97 feet in the pumped well and 0.76 feet in the observation well, MD23-15.

MACDILL AFB LOCATION OF WELLS USED FOR AQUIFER PUMPING TEST AT SITE 23

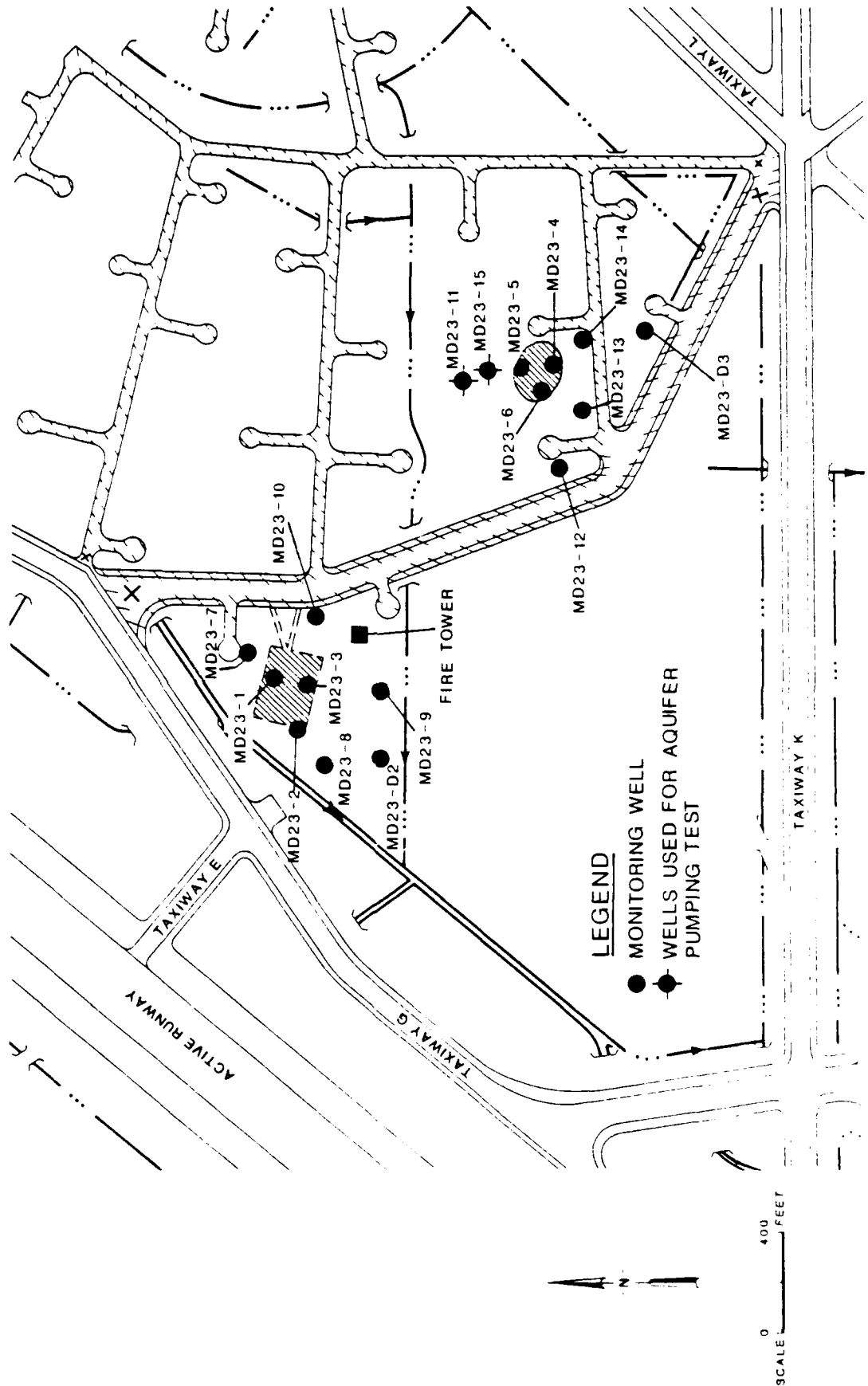


FIGURE E.1

TABLE E.1
WELL CONSTRUCTION SUMMARY

Well ID	Elevation Top of Casing (Feet, MSL)	Total Hole Depth (feet)	Bottom of Screen (feet)	Top of Screen (feet)	Well Diameter (inches)
MD 23-11	12.51	22	19	4	4
MD 23-15	12.55	17	14	4	2

MACDILL AFB WELL ARRANGEMENT AND CROSS-SECTION FOR AQUIFER PUMPING TEST

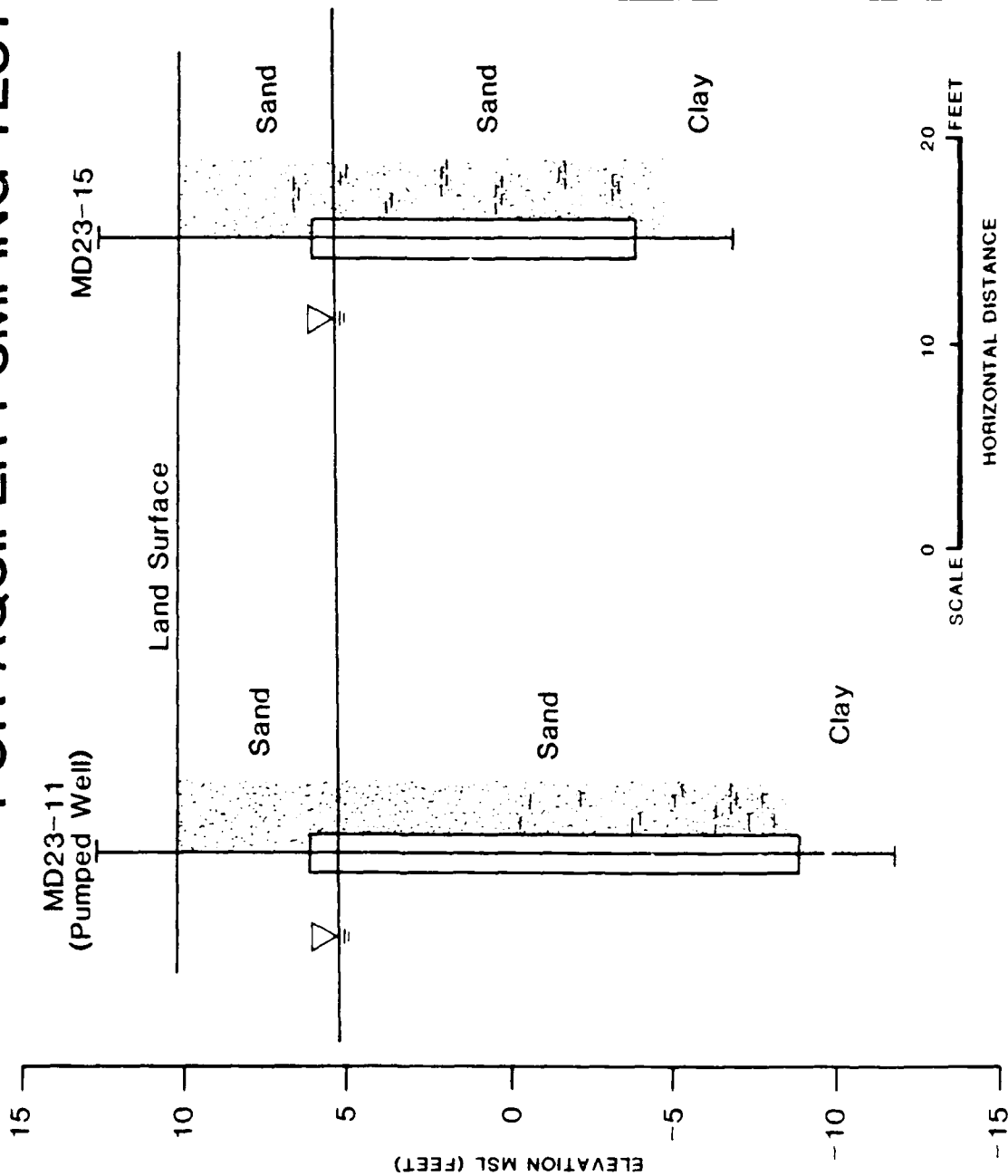


FIGURE E.2

The water-level data for the pumped well and the observation well were used to compute the hydraulic properties of the surficial aquifer. The modified nonequilibrium formula (Ferris, and others, 1962) and water-level data for the observation well were used to compute transmissivity and storage coefficient. The modified nonequilibrium formula (Ferris, and others, 1962) and water-level data for the pumped well were used to compute transmissivity. Hydraulic conductivity for the surficial aquifer was estimated based on computed transmissivities and the average saturated thickness at wells MD23-11 and MD23-15. The results of the analyses are listed in Table E.2. The data plots and analyses are presented in Figures E.3 and E.4.

Average hydraulic properties for the surficial aquifer were estimated based on the results of the aquifer pumping test. The average hydraulic conductivity of the sandy deposits is approximately 155 gallons per day per square foot. Storage coefficient, 0.016, is based upon the results of the drawdown analysis for the observation well MD23-15. The form of the modified nonequilibrium formula used for the computation of the hydraulic properties is:

$$T = \frac{264.2}{s} \quad \text{and} \quad S = 2.29 \times 10^{-4} \frac{T t_0}{r^2}$$

Where

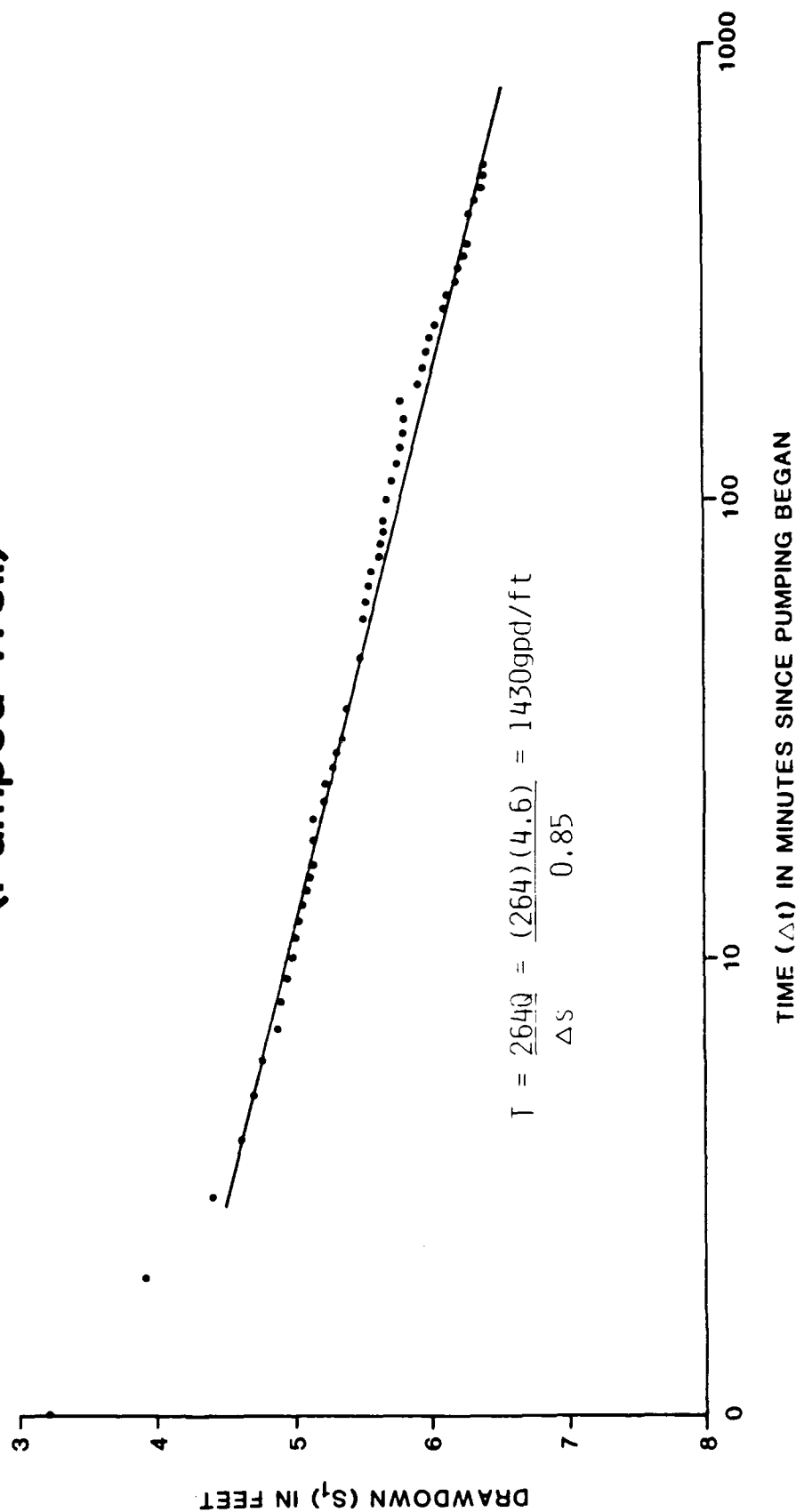
- Q = Average pumping rate, in gallons per minute;
- S = Storage coefficient, no dimensions;
- T = Transmissivity, in gallons per day per foot;
- r = Distance from pumped well to observation well, in feet;
- s = Change in drawdown over one log cycle for a semi-log plot of time and drawdown; and
- t_0 = Time at which a straight line drawn through the data on a semi-log plot intercepts the zero drawdown time.

TABLE E.2
SUMMARY OF AQUIFER PUMPING TEST RESULTS

Well No.	Transmissivity (gpd/ft)	Storage Coefficient	Saturated Thickness* (feet)	Hydraulic Conductivity (gpd/ft ²)
MD 23-11	1450	--	11.7	124
MD 23-15	2160	0.016	11.7	185
Average for Test	1805			155

* Average saturated thickness

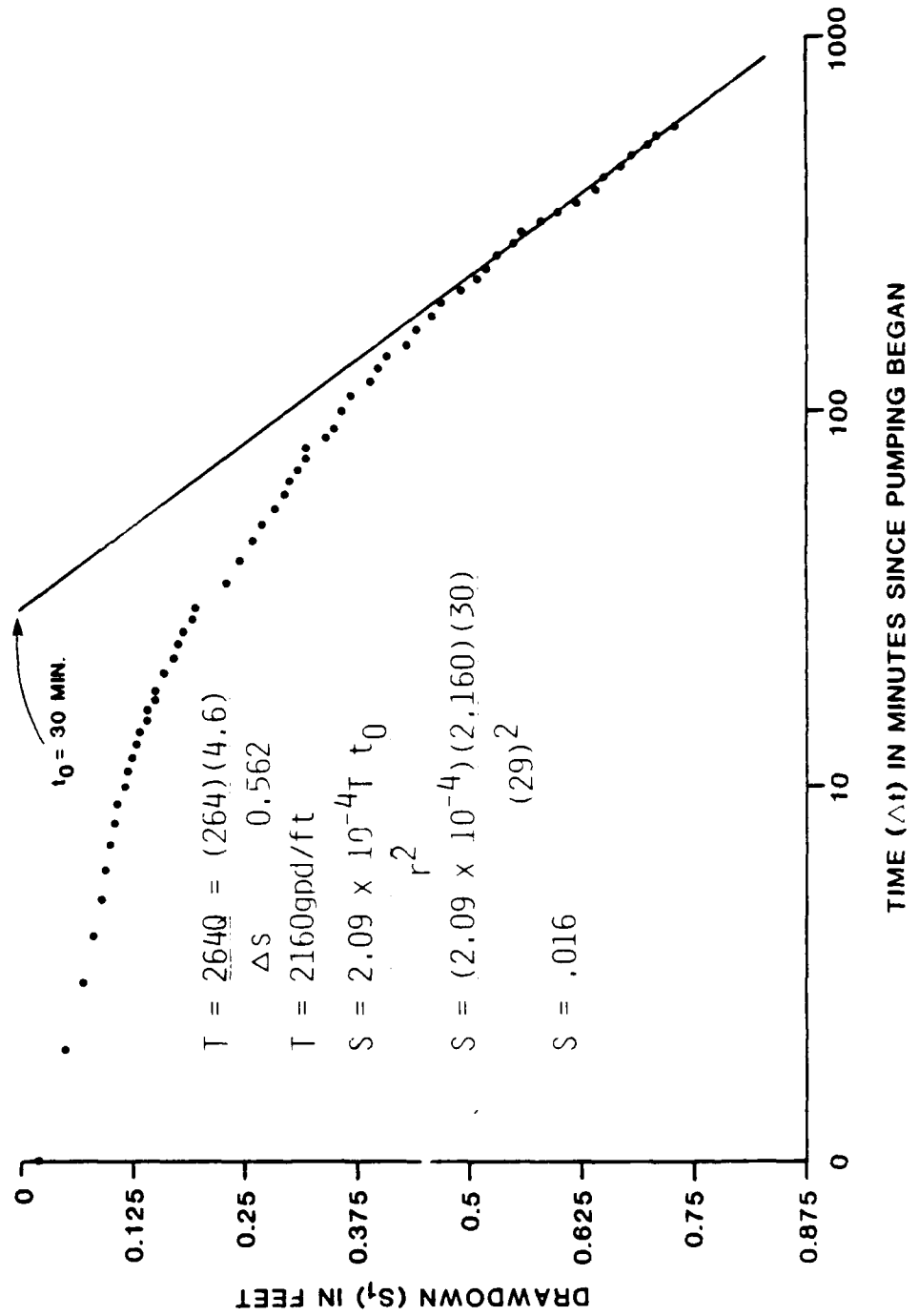
MODIFIED NONEQUILIBRIUM ANALYSIS FOR WELL MD23-11 (Pumped Well)



$$T = \frac{264Q}{\Delta s} = \frac{(264)(4.6)}{0.85} = 1430 \text{ gpd/ft}$$

FIGURE E.4

MODIFIED NONEQUILIBRIUM ANALYSIS FOR WELL MD23-15 (Observation Well)



E.2 WATER LEVEL DATA FOR AQUIFER PUMPING TEST

Water levels were recorded for the pumped well (MD23-11) and for the observation well (MD23-15) during the aquifer pumping test. These data were kept in the field and tabulated during the drawdown and recovery phases of the test (Tables E.3 and E.4). In the following tables, the column headings have these meanings.

Date:	Date of reading.
Time:	Time of reading, Eastern Daylight Time.
Depth to Water:	The depth to water below the measuring point, in feet. An electric water level indicator was used to make all readings. These indicators read directly the depth to water below the measuring point.
Flow:	Volume of water, in gallons per minute, discharged from the pumping well. These measurements were taken from the in-line flow meter.
Remarks:	Any pertinent remarks.

TABLE E.3
WATER LEVEL DATA FOR THE PUMPED WELL (MD23-11)
DURING THE AQUIFER PUMPING TEST

Well Number: MD23-11
Well Location: Site 23 Pumped Well
Measuring Point: Top of PVC Casing
Elevation of MP: 12.51

Date	Time (EDT)	Depth to Water (feet)	Flow (gpm)	Remarks
15 October 1968	0800	7.13		
	1000	7.17		
	1525	7.23		
16 October 1968	0815	7.24		Pump on
	0820	7.24		
	0821	10.95		
	0822	11.95		All water level measurements were made using an electric tape.
	0823	12.73		
	0824	13.36		
	0825	13.27		
	0826	13.31		
	0827	13.45		
	0828	13.57		
	0829	13.61		
	0830	13.74		
	0831	13.81		
	0832	13.91		
	0833	14.01		
	0834	14.11		
	0835	14.21		
	0836	14.31		
	0837	14.41		
	0838	14.51		
	0839	14.61		
	0840	14.71		
	0841	14.81		
	0842	14.91		
	0843	14.01		
	0844	14.11		
	0845	14.21		
	0846	14.31		
	0847	14.44	4.45	
	0848	14.41		
	0849	14.51		
	0850	14.61		
	0851	14.71		
	0852	14.75		
	0853	14.76		

TABLE E.3
WATER LEVEL DATA FOR THE PUMPED WELL (MD23-11)
DURING THE AQUIFER PUMPING TEST
(continued)

Well Number: MD23-11
Well Location: Site 23 Pumped Well
Measuring Point: Top of PVC Casing
Elevation of MP: 12.51

Date	Time (EDT)	Depth to Water (feet)	Flow (gpm)	Remarks
16 October 1986	0920	14.82	4.46	
	0925	14.87		
	0930	14.90		
	0935	15.02		
	0940	15.07		
	0945	15.08		
	0950	15.09	4.47	
	1000	15.16		
	1010	15.25		
	1020	15.33	4.43	
	1030	15.38		
	1040	15.44		
	1050	15.48	4.49	
	1105	15.37		
	1120	15.72	4.49	
	1135	15.77		
	1150	15.95		
	1205	15.93		
	1220	16.04	4.54	
	1240	16.21		
	1300	16.30	4.52	
	1320	16.44		
	1340	16.58	4.53	
	1400	16.63		
	1420	16.68	4.51	
	1450	16.73		
	1520	16.84	4.51	
	1550	16.88		
	1620	17.01	4.51	
	1650	17.07		
	1720	17.11	4.51	
	1750	17.21		
	1804	--		Pump off
	1805	11.95		
	1806	10.35		

TABLE E.3
WATER LEVEL DATA FOR THE PUMPED WELL (MD23-11)
DURING THE AQUIFER PUMPING TEST
(continued)

Well Number: MD23-11
Well Location: Site 23 Pumped Well
Measuring Point: Top of PVC Casing
Elevation of MP: 12.51

Date	Time (EDT)	Depth to Water (feet)	Flow (gpm)	Remarks
16 October 1986	1807	9.63		
	1808	9.29		
	1809	9.01		
	1810	8.81		
	1811	8.65		
	1812	8.47		
	1813	8.37		
	1814	8.31		
	1816	8.23		
	1818	8.24		
	1820	8.32		
	1822	8.19		
	1824	8.17		
	1826	8.15		
	1828	8.13		
	1830	8.12		
	1832	8.12		
	1834	8.10		
	1836	8.06		
	1844	8.03		
	1849	8.01		
	1854	7.99		
	1859	7.96		
	1904	7.95		
	1909	7.93		
	1914	7.91		
	1919	7.90		
	1924	7.89		
	1929	7.88		
	1934	7.87		
	1944	7.85		
	1954	7.82		
	2004	7.81		

TABLE E.4
WATER LEVEL DATA FOR THE OBSERVATION WELL (MD 23-15)
DURING THE AQUIFER PUMPING TEST

WELL NUMBER: MD 23-15
WELL LOCATION: Observation Well
MEASURING POINT: Top of PVC Casing
ELEVATION OF MP: 12.55 feet, MSL

Date	Time (EDT)	Depth to Water (feet)	Remarks
16 October 1986	0755	7.07	
	0820	7.07	Pump On
	0821	7.09	
	0822	7.12	
	0823	7.14	
	0824	7.15	
	0825	7.16	
	0826	7.16	
	0827	7.17	
	0828	7.17	
	0829	7.18	
	0830	7.18	
	0831	7.19	
	0832	7.19	
	0833	7.20	
	0834	7.20	
	0835	7.21	
	0836	7.21	
	0838	7.22	
	0840	7.23	
	0842	7.24	
	0844	7.24	
	0846	7.25	
	0848	7.26	
	0850	7.26	
	0855	7.30	
	0900	7.31	
	0905	7.33	
	0910	7.34	
	0915	7.35	
	0920	7.36	
	0925	7.38	
	0930	7.39	
	0935	7.41	
	0940	7.41	
	0945	7.42	
	0950	7.43	

TABLE E.4
WATER LEVEL DATA FOR THE OBSERVATION WELL (MD 23-15)
DURING THE AQUIFER PUMPING TEST
(Continued)

Date	Time (EDT)	Depth to Water (feet)	Remarks
	1000	7.44	
	1010	7.45	
	1020	7.47	
	1030	7.48	
	1040	7.49	
	1050	7.51	
	1105	7.52	
	1120	7.54	
	1135	7.55	
	1150	7.57	
	1205	7.59	
	1221	7.60	
	1240	7.62	
	1300	7.64	
	1320	7.65	
	1340	7.67	
	1400	7.69	
	1420	7.71	
	1450	7.73	
	1520	7.74	
	1550	7.77	
	1620	7.78	
	1650	7.80	
	1720	7.81	
	1750	7.83	
	1804	--	Pump Off
	1805	7.81	
	1806	7.79	
	1807	7.77	
	1808	7.76	
	1809	7.75	
	1810	7.74	
	1811	7.73	
	1812	7.72	
	1813	7.71	
	1814	7.71	
	1816	7.69	
	1818	7.68	
	1820	7.68	
	1822	7.67	
	1824	7.67	

TABLE E.4
WATER LEVEL DATA FOR THE OBSERVATION WELL (MD 23-15)
DURING THE AQUIFER PUMPING TEST
(Continued)

Date	Time (EDT)	Depth to Water (feet)	Remarks
	1826	7.66	
	1828	7.65	
	1830	7.65	
	1832	7.64	
	1834	7.63	
	1839	7.62	
	1844	7.61	
	1849	7.60	
	1854	7.59	
	1859	7.58	
	1904	7.57	
	1909	7.56	
	1914	7.55	
	1919	7.54	
	1924	7.54	
	1929	7.53	
	1934	7.52	
	1944	7.51	
	1954	7.50	
	2004	7.49	

E.3 COMPUTATIONS FOR DRAWDOWN AND RECOVERY ANALYSES

Drawdowns in the pumped well and the observation well during the aquifer pumping test were computed based on the water-level observations. Computations are in the following tables (Tables E.5 and E.6). In these tables, the column headings have the following meanings.

Date:	Date of reading.
Time:	Time of reading, Eastern Daylight Time.
t:	Time from beginning of aquifer pumping test, in minutes.
Depth to Water:	Depth to water below the measuring point, in feet.
s:	Drawdown in the well, in feet. Drawdown is computed by subtracting the depth to water from the static water level measured prior to starting the test.
$s^2/2M$:	A correction to account for dewatering of the aquifer system, in feet. The initial saturated thickness of the system in M.
s_1 :	The drawdown in the well corrected for the effects of dewatering, in feet. $s_1 = s - (s^2/2M)$.
Remarks:	Any pertinent remarks.

Recovery in the pumped well and observation well during the aquifer pumping test were computed based on water-level measurements. The following tables (Tables E.7 and E.8) are the basis for computations. Headings in these tables have the following meanings:

Date:	Date of reading.
t:	Time since testing began, in minutes.
t':	Time since pumping ended, in minutes.
t/t':	Ratio of total time since test began to time since pumping ended.
Depth to water:	Depth to water below the measuring point, in feet.
s:	Drawdown in the well, in feet. Computed by subtracting the depth to water from the static water level measured prior to starting the test.

TABLE E.5
DRAWDOWN FOR THE PUMPED WELL (MD 23-11)

Well Number: MD 23-11
Well Location: Pumping Well
Measuring Point: Top of Casing (PVC)
Elevation of MP: 12.51 feet MSL

Date	Time (EDT)	t (min)	Depth to Water (feet)	s (feet)	$s^2/2M$ (feet)	s_1 (feet)	Remarks
10/16/86	0815	(-5)	7.24	--	--	--	
	0820	0	7.24	--	--	--	Pump On
	0821	1	10.95	3.71	0.49	3.22	
	0822	2	11.95	4.71	0.80	3.91	
	0823	3	12.73	5.49	1.08	4.41	
	0824	4	13.06	5.82	1.22	4.60	
	0825	5	13.20	5.96	1.28	4.63	
	0826	6	13.31	6.07	1.32	4.75	
	0827	7	13.45	6.21	1.39	4.82	
	0828	8	13.57	6.33	1.44	4.89	
	0829	9	13.66	6.42	1.48	4.94	
	0830	10	13.74	6.50	1.52	4.98	
	0831	11	13.80	6.56	1.55	5.01	
	0832	12	13.84	6.60	1.57	5.03	
	0833	13	13.88	6.64	1.58	5.06	
	0834	14	13.93	6.69	1.61	5.08	
	0835	15	13.98	6.74	1.63	5.11	
	0836	16	14.02	6.78	1.65	5.13	
	0838	18	14.07	6.83	1.68	5.15	
	0840	20	14.11	6.87	1.70	5.17	
	0842	22	14.20	6.96	1.74	5.22	
	0844	24	14.25	7.01	1.77	5.24	
	0846	26	14.30	7.06	1.79	5.27	
	0848	28	14.34	7.10	1.81	5.29	
	0850	30	14.44	7.20	1.86	5.34	
	0855	35	14.48	7.24	1.88	5.36	
	0900	40	14.57	7.33	1.93	5.40	
	0905	45	14.72	7.48	2.01	5.47	
	0910	50	14.75	7.51	2.03	5.48	
	0915	55	14.76	7.52	2.03	5.49	
	0920	60	14.82	7.58	2.07	5.51	
	0925	65	14.87	7.63	2.09	5.54	
	0930	70	14.90	7.66	2.11	5.55	
	0935	75	15.02	7.78	2.18	5.60	
	0940	80	15.07	7.83	2.20	5.63	
	0945	85	15.08	7.84	2.21	5.63	
	0950	90	15.09	7.85	2.22	5.63	
	1000	100	15.16	7.92	2.31	5.67	
	1010	110	15.25	8.01	2.35	5.70	

TABLE E.5
DRAWDOWN FOR THE PUMPED WELL (MD 23-11)
(Continued)

Well Number: MD 23-11
Well Location: Pumping Well
Measuring Point: Top of Casing (PVC)
Elevation of MP: 12.51 feet MSL

Date	Time (EDT)	t (min)	Depth to Water (feet)	s (feet)	$s^2/2M$ (feet)	s_1 (feet)	Remarks
	1020	120	15.33	8.09	2.38	5.74	
	1030	130	15.38	8.14	2.42	5.76	
	1040	140	15.44	8.20	2.42	5.78	
	1050	150	15.48	8.24	2.44	5.80	
	1105	165	15.37	8.13	2.38	5.75	
	1120	180	15.72	8.48	2.58	5.90	
	1135	195	15.77	8.53	2.62	5.91	
	1150	210	15.85	8.61	2.66	5.95	
	1205	225	15.93	8.69	2.71	5.98	
	1220	240	16.04	8.80	2.78	6.02	
	1240	260	16.21	8.97	2.89	6.08	
	1300	280	16.30	9.06	2.95	6.11	
	1320	300	16.44	9.20	3.04	6.16	
	1340	320	16.58	9.34	3.14	6.20	
	1400	340	16.63	9.39	3.17	6.22	
	1420	360	16.68	9.44	3.20	6.24	
	1450	390	16.73	9.49	3.24	6.25	
	1520	420	16.84	9.60	3.31	6.29	
	1550	450	16.88	9.64	3.34	6.30	
	1620	480	17.01	9.77	3.43	6.34	
	1650	510	17.07	9.83	3.47	6.36	
	1720	540	17.11	9.87	3.50	6.37	
	1750	570	17.21	9.97	3.57	6.40	
	1804	584					Pump Off

TABLE E.6
DRAWDOWN DATA FOR THE OBSERVATION WELL (MD 23-15)

Well Number: MD 23-15
Well Location: Observation
Measuring Point: Top of Casing (PVC)
Elevation Point: 12.55 feet MSL

Date	Time (EDT)	Δt (min)	Depth to Water (feet)	s (feet)	$s^2/2M$ (feet)	s_1 (feet)	Remarks
10/16/86	0755		7.07	--	--	--	
	0820	0	7.07	--	--	--	Pump On
	0821	1	7.09	.02	--	.02	
	0822	2	7.12	.05	--	.05	
	0823	3	7.14	.07	--	.07	
	0824	4	7.15	.08	--	.08	
	0825	5	7.16	.09	--	.09	
	0826	6	7.16	.09	--	.09	
	0827	7	7.17	.10	--	.10	
	0828	8	7.17	.10	--	.10	
	0829	9	7.18	.11	--	.11	
	0830	10	7.18	.11	--	.11	
	0831	11	7.19	.12	--	.12	
	0832	12	7.19	.12	--	.12	
	0833	13	7.20	.13	--	.13	
	0834	14	7.20	.13	--	.13	
	0835	15	7.21	.14	--	.14	
	0836	16	7.21	.14	--	.14	
	0838	18	7.22	.15	--	.15	
	0840	20	7.23	.16	--	.16	
	0842	22	7.24	.17	--	.17	
	0844	24	7.24	.17	--	.17	
	0846	26	7.25	.18	--	.18	
	0848	28	7.26	.19	--	.19	
	0850	30	7.26	.19	--	.19	
	0855	35	7.30	.23	--	.23	
	0900	40	7.31	.24	--	.24	
	0905	45	7.33	.26	--	.26	
	0910	50	7.34	.27	--	.27	
	0915	55	7.35	.28	--	.28	
	0920	60	7.36	.29	--	.29	
	0925	65	7.38	.31	.01	.30	
	0930	70	7.39	.32	.01	.31	
	0935	75	7.41	.34	.01	.33	
	0940	80	7.41	.34	.01	.33	
	0945	85	7.42	.35	.01	.34	
	0950	90	7.43	.36	.01	.35	
	1000	100	7.44	.37	.01	.36	
	1010	110	7.45	.38	.01	.37	
	1020	120	7.47	.40	.01	.39	

TABLE E.6
DRAWDOWN DATA FOR THE OBSERVATION WELL (MD 23-15)
(Continued)

Well Number: MD 23-15
Well Location: Observation
Measuring Point: Top of Casing (PVC)
Elevation Point: 12.55 feet MSL

Date	Time (EDT)	Δt (min)	Depth to Water (feet)	s (feet)	$s^2/2M$ (feet)	s_1 (feet)	Remarks
	1030	130	7.48	.41	.01	.40	
	1040	140	7.49	.42	.01	.41	
	1050	150	7.51	.44	.01	.43	
	1105	165	7.52	.45	.01	.44	
	1120	190	7.54	.47	.01	.45	
	1135	195	7.55	.48	.01	.47	
	1150	210	7.57	.50	.01	.49	
	1205	215	7.59	.52	.01	.51	
	1220	240	7.60	.53	.01	.52	
	1240	260	7.62	.55	.02	.53	
	1300	280	7.64	.57	.02	.55	
	1320	300	7.65	.58	.02	.56	
	1340	320	7.67	.60	.02	.58	
	1400	340	7.69	.62	.02	.60	
	1420	360	7.71	.64	.02	.62	
	1450	390	7.73	.66	.02	.64	
	1520	420	7.74	.67	.02	.65	
	1620	480	7.78	.71	.03	.67	
	1650	510	7.80	.73	.03	.70	
	1720	540	7.81	.74	.03	.71	
	1750	570	7.83	.76	.03	.73	
	1804	584					Pump Off

TABLE E.7
RECOVERY DATA FOR THE PUMPED WELL (MD 23-11)

WELL NUMBER: MD 23-11
WELL LOCATION: Pumping Well
MEASURING POINT Top of Casing - (PVC)
ELEVATION OF MP: 12.51 Feet MSL

Date	t (min)	t' (min)	t/t' (min)	Depth to Water (feet)	s (feet)	$s^2/2M$ (feet)	s (feet)
10/16/86	584	0	--	--	--	--	--
	585	1	585.0	11.95	4.71	.78	3.93
	586	2	293.0	10.35	3.11	.34	2.77
	587	3	196.0	9.68	2.44	.21	2.23
	588	4	147.0	9.29	2.05	.15	1.90
	589	5	118.0	9.01	1.77	.11	1.66
	590	6	98.0	8.81	1.57	.09	1.48
	591	7	84.0	8.65	1.41	.07	1.34
	592	8	74.0	8.47	1.23	.05	1.18
	593	9	66.0	8.37	1.13	.04	1.09
	594	10	59.0	8.31	1.07	.04	1.03
	596	12	50.0	8.28	1.04	.04	1.00
	598	14	43.0	8.24	1.00	.04	.96
	600	15	37.5	8.22	.98	.03	.95
	602	18	33.4	8.19	.95	.03	.92
	604	20	30.2	8.17	.93	.03	.90
	606	22	27.5	8.15	.91	.03	.89
	608	24	25.3	8.13	.89	.03	.89
	610	26	23.5	8.12	.88	.03	.85
	612	28	21.9	8.10	.86	.03	.83
	614	30	20.5	8.09	.85	.03	.82
	619	35	17.7	8.06	.82	.02	.80
	624	40	15.6	8.03	.79	.02	.77
	629	45	14.0	8.01	.77	.02	.75
	634	50	12.7	7.99	.75	.02	.73
	639	55	11.6	7.96	.72	.02	.70
	644	60	10.7	7.95	.71	.02	.69
	649	65	10.0	7.93	.69	.02	.67
	654	70	9.3	7.91	.67	.02	.65
	659	75	8.8	7.90	.66	.02	.64
	664	80	8.3	7.89	.65	.01	.64
	669	85	7.9	7.88	.64	.01	.63
	674	90	7.6	7.87	.63	.01	.62
	684	100	6.8	7.85	.61	.01	.60
	694	110	6.3	7.82	.58	.01	.57
	704	120	5.9	7.81	.57	.01	.56

TABLE E.8
RECOVERY DATA FOR OBSERVATION WELL (MD 23-15)

WELL NUMBER: MD 23-15
WELL LOCATION: Observation Well
MEASURING POINT: Top of Casing - (PVC)
ELEVATION OF MP: 12.55 Feet MSL

Date	Δt (min)	t' (min)	t/t' (min)	Depth to Water (feet)	s (feet)	$s^2/2M$ (feet)	s' (feet)
10/16/86	584	0	--	--	--	--	--
	585	1	585.0	7.81	.74	.03	.71
	586	2	293.0	7.79	.72	.03	.69
	587	3	196.0	7.77	.71	.03	.68
	588	4	147.0	7.76	.69	.03	.66
	589	5	118.0	7.75	.68	.02	.66
	590	6	98.0	7.74	.67	.02	.65
	591	7	84.0	7.73	.66	.02	.64
	592	8	74.0	7.72	.65	.02	.63
	593	9	66.0	7.715	.645	.02	.625
	594	10	59.0	7.71	.64	.02	.62
	596	12	50.0	7.69	.62	.02	.60
	598	14	43.0	7.685	.615	.02	.595
	600	16	37.5	7.68	.61	.02	.59
	602	18	33.4	7.675	.605	.02	.585
	604	20	30.2	7.67	.60	.02	.58
	606	22	27.5	7.66	.59	.02	.57
	608	24	25.3	7.655	.585	.02	.565
	610	26	23.5	7.65	.58	.02	.56
	612	28	21.9	7.64	.57	.02	.55
	614	30	20.5	7.635	.565	.02	.545
	619	35	17.7	7.62	.55	.02	.53
	624	40	15.6	7.61	.54	.02	.52
	629	45	14.0	7.60	.53	.01	.52
	634	50	12.7	7.59	.52	.01	.51
	639	55	11.6	7.58	.51	.01	.50
	644	60	10.7	7.57	.50	.01	.49
	649	65	10.0	7.56	.49	.01	.48
	654	70	9.3	7.55	.48	.01	.47
	659	75	8.8	7.545	.475	.01	.46
	664	80	8.3	7.54	.47	.01	.465
	669	85	7.9	7.53	.46	.01	.45
	674	90	7.5	7.52	.45	.01	.44
	684	100	6.8	7.51	.44	.01	.43
	694	110	6.3	7.50	.43	.01	.42
	704	120	5.9	7.49	.42	.01	.41

$s^2/2M$: A correction to account for dewatering of the aquifer system, in feet. The initial saturated thickness of the system is M.

s' : Residual drawdown in the well, correct for dewatering, in feet. $s' = s - (s^2/2M)$.

APPENDIX F
GEOPHYSICAL SURVEY PROGRAM

- F.1 Geophysical Methodology
- F.2 Site Specific Results
- F.3 Summary
- F.4 Site II Geophysical Survey Results
(October 1987 Survey)

APPENDIX F
GEOPHYSICAL SURVEY PROGRAM

The geophysical survey program conducted at MacDill AFB consisted of electrical resistivity surveys, a magnetic survey, and a metal detector survey. The purpose of these surveys was generally to determine appropriate locations for new monitoring wells based on observed anomalies that would possibly indicate the extent and direction of contaminant migration. This appendix provides the data collected during these surveys and conclusions based upon data interpretation. The appendix is organized as follows:

- o Geophysical Methodology
- o Site Specific Results
- o Summary

F.1 GEOPHYSICAL METHODOLOGY

F.1.1 Electrical Resistivity Methodology

The electrical resistivity survey consisted of both vertical and horizontal resistivity measurements. These measurements, obtained with a Bison Earth Resistivity Model 2350B meter, indicated the relative electrical resistance of the earth, in ohms, to the conductance of an induced electric current through metal probes or electrodes driven into the ground. As an example of the resistive nature of the subsurface, an uncontaminated fresh-water aquifer will exhibit a relatively high resistivity, whereas a fresh-water aquifer contaminated with polar organic molecules or ionized metals will exhibit a relatively low resistivity. Also, fractures or solution cavities will exhibit a moderately low resistivity compared to solid bedrock.

Vertical resistivity measurements, termed soundings, indicate the variation of resistivity at different depths beneath one point on the ground surface. The resistivity sounding method applied at MacDill Air

Force Base was the "Modified Wenner Electrode Array" (Carrington and Watson, 1981). In this method the current electrodes (those furthest from the center of the array) are stationary while the potential electrodes (those closest to the center of the array) are moved away from the center at equally spaced distances. Figure F.1 illustrates the basic resistivity setup for soundings. In the "Modified Wenner Electrode Array" the potential electrode distance closely approximates the depth of investigation into the subsurface. For example, a sounding with a total potential electrode distance of thirty feet would indicate resistivity values at approximately thirty feet below the ground surface. The midpoint of the array is considered the point on the surface directly above the measured resistivity.

Horizontal resistivity measurements, on the other hand, are termed "profiles" and indicate the variation of resistivity at one approximate depth over many ground-surface locations. The resistivity profile method applied at MacDill Air Force Base was the standard Wenner Array (Wenner, 1916). In this method the current and potential electrodes are driven into the ground at equal distances from one another. Figure F.2 illustrates the basic resistivity setup for profiles. The depth of investigation is a zone of the subsurface approximately three-fourths to one times the electrode spacing. For example, an electrode spacing of fifty feet in the Wenner Array would investigate a zone of the subsurface between approximately 38 to 50 feet deep. The midpoint of the array is considered the point on the surface directly above the measured resistivity. Three to four Wenner Arrays were utilized at each station to distinguish shallow and deep subsurface variations in resistivity. The presentation of the profile data for each site is in the form of computer contour plots.

F.1.2 Magnetic Methodology

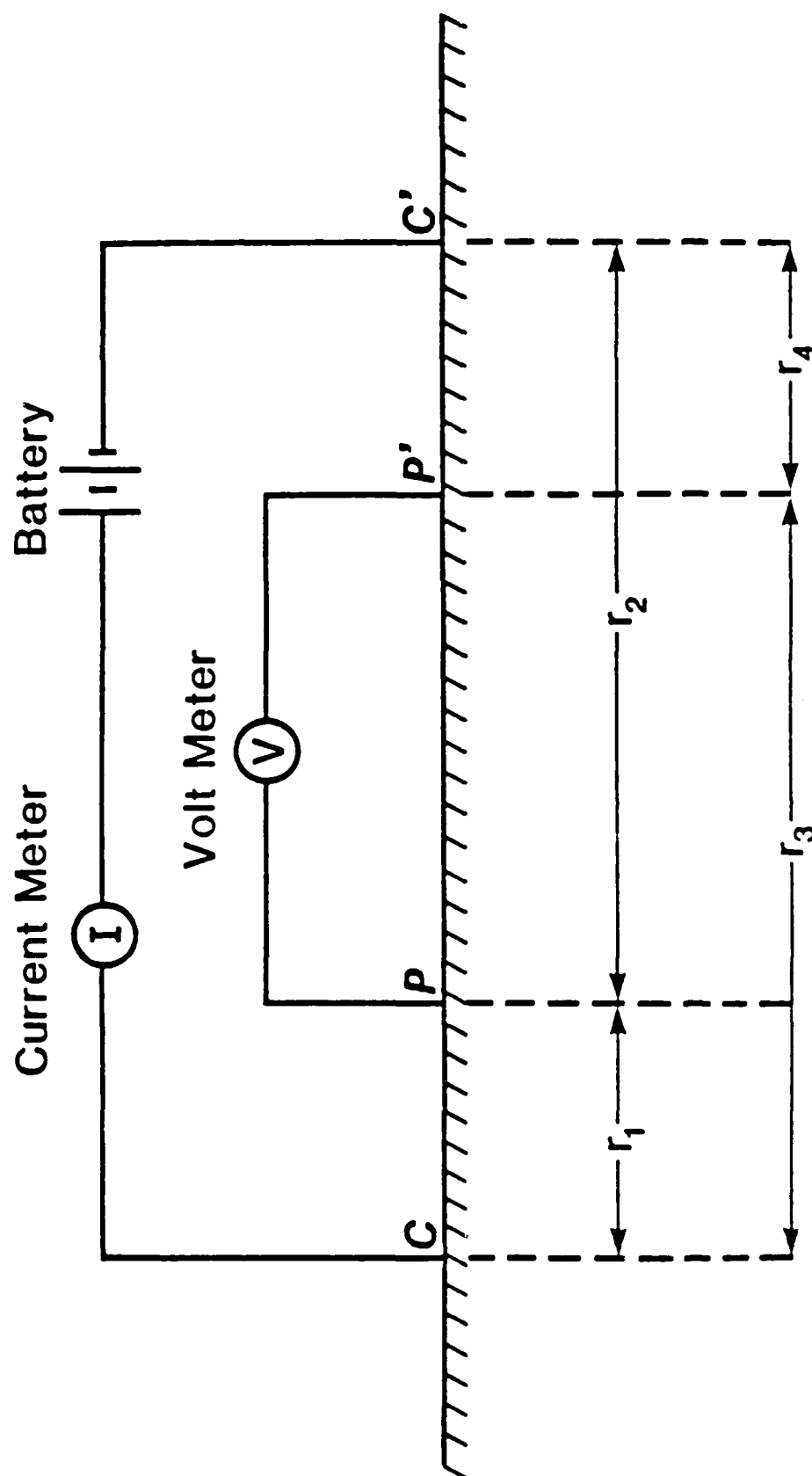
The magnetic survey consisted of station to station measurements to locate buried fuel storage tanks at Site B. The measurements were obtained with a Geometrics G816/826A Proton Magnetometer which indicates the total magnetic field intensity in gammas. The magnetometer operates by temporarily polarizing the nuclei of the hydrogen atom in a sample of hydrocarbon fluid with a uniform magnetic field generated by a current in a coil of wire within the sensor. The spinning protons behave like

Formula for Apparent Resistivity

$$\rho = (2\pi R) \left[\frac{1}{\frac{1}{r_1} - \frac{1}{r_2} - \frac{1}{r_3} + \frac{1}{r_4}} \right]$$

"MODIFIED WENNER" ARRAY

DIAGRAM OF ELECTRODE SPACING



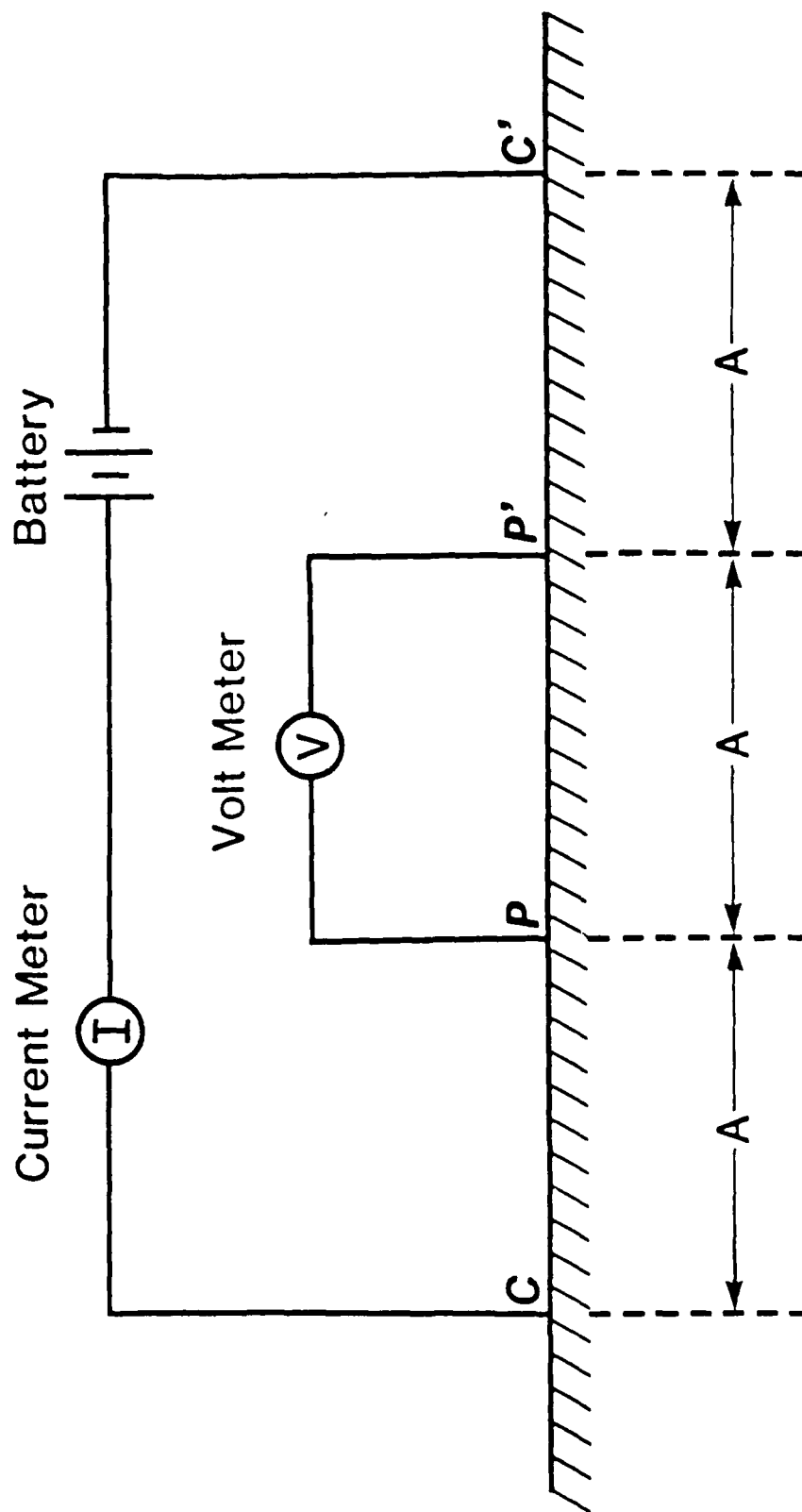
SOURCE: Carrington & Watson, 1981

Formula for Apparent Resistivity

$$\rho = A(2\pi \frac{V}{I})$$

WENNER ARRAY

DIAGRAM OF ELECTRODE SPACING



SOURCE: Bison, 1975

small, spinning magnetic dipoles which, when the current is removed, precess about the direction of the earth's magnetic field. The precessing protons generate a signal in the coil within the sensor, whose frequency is precisely proportional to the total magnetic field intensity. This frequency is measured by a digitizer within the unit and converted to gammas with an accuracy of 1 gamma in the average earth magnetic field of 50,000 gammas (Breiner, 1973). As an example, background readings made some distance away from a site and metallic or electrical objects indicates the natural local total magnetic field intensity. As a magnetic target is approached there is an initial decrease in the local total magnetic field due to interference produced by the target. This decrease in magnetic field intensity is followed by a major increase in the magnetic field above the local background readings. This is indicated by the magnetometer as increased gamma readings. The initial decrease in gamma readings causes the target to appear slightly ahead of its actual position along the line of the survey. This apparent shift of the target (heading factor) must be compensated for in locating the target.

F.1.3 Metal Detection Methodology

The metal detection survey was conducted with a Fisher TW-5 Pipe and Cable Locator. The TW-5 was used to locate buried pipes, cables, various metallic debris and to locate the boundaries of the buried fuel storage tanks at Site B. The TW-5 has an effective depth of penetration of up to eight feet depending upon the size of the target, the type of soil, the amount of interference, etc. The TW-5 operates by creating an alternating magnetic field around the transmitter coil. This primary magnetic field is nullified such that the receiver coil is not affected by the primary field. This is accomplished by orienting the planes of the two coils perpendicular to each other. The primary magnetic field will, therefore, induce eddy currents in a metallic target within range of the instrument. The eddy currents produce a secondary magnetic field which disrupts the existing null condition. The result is a deflection of the meter needle and an audio signal when a metallic object is within range (Benson, et.al., 1982).

F.1.4 Electromagnetic Methodology

Conductivity measurements were obtained in the area believed to contain the Chemical Munitions Burial Area (Site 11) with a Geonics EM-31 ground conductivity meter which measures the conductivity of the ground to a depth of approximately six meters. The EM-31 operates by transmitting electrical current into the ground in the form of circular loops. The current loops generate a magnetic field in the ground which is directly proportional to the terrain conductivity. The instrument receiver measures the induced magnetic field, converts it to an output voltage, and displays the apparent conductivity in millimhos per meter (Geonics 1984).

The apparent conductivity of the ground measured by this method is a function of the ability of subsurface materials to transmit electrical currents. The EM-31 was utilized in the area to locate areas of high conductivity indicative of conductive wastes, conductive ground water and/or metallic debris.

F.2 SITE SPECIFIC RESULTS

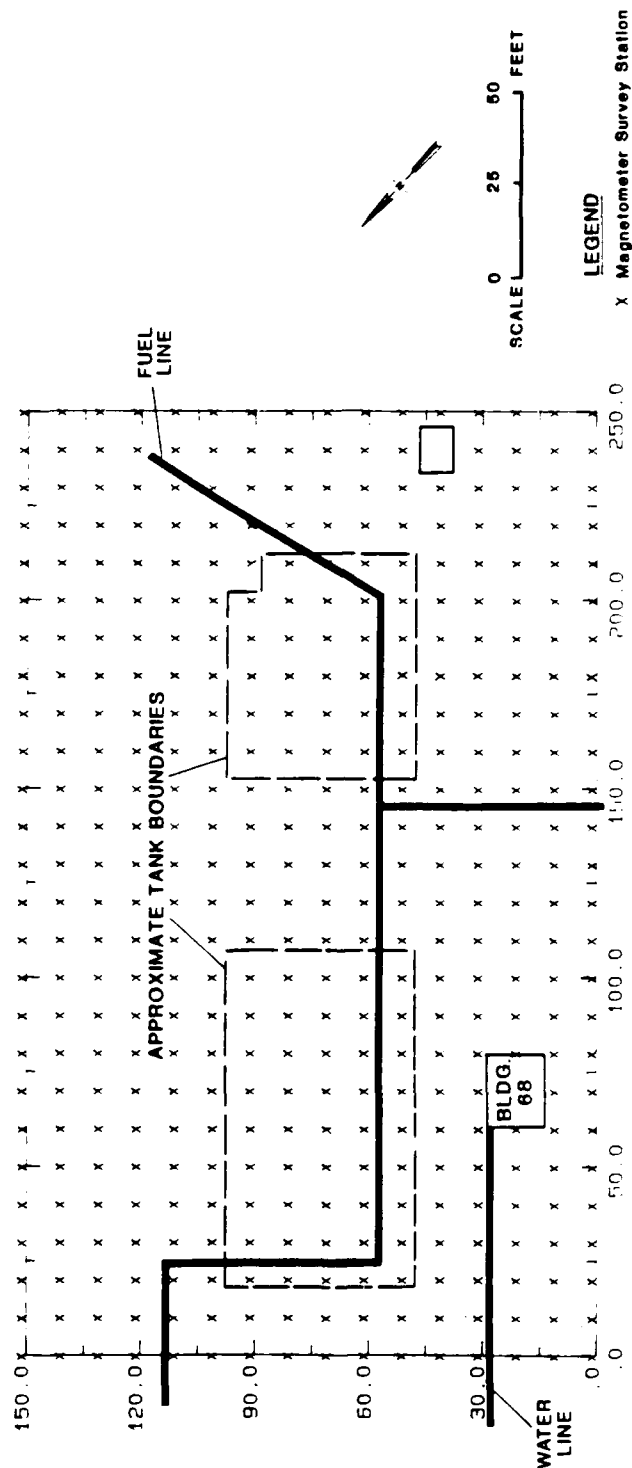
F.2.1 Site B (Former Fuel Storage Area)

Magnetic Survey

A magnetic survey was conducted at Site B on August 7, 1986. Prior to conducting the magnetic survey, a Fisher Model TW-5 Pipe and Cable Locator was used at the site to see if the tanks could be detected. The metal detector did respond to the metallic fuel tanks as well as the pipes which were used to transport the fuel. The boundaries of two sets of fuel tanks were located and marked temporarily at the site with flags. The dimensions of the tanks correlated well with a construction drawing of the site given to ES by MacDill AFB Civil Engineering.

To further confirm the location of the fuel tanks, a magnetic survey was conducted at the site. The site was divided into ten foot increments and magnetometer readings were taken every ten feet across the suspected area. Figure F.3 shows the locations of the magnetometer stations. Figure F.4 shows the results of the magnetic survey as a contour plot of the values at each station. The approximate locations of the two sets of fuel tanks and pipe locations in Figures F.3 and F.4

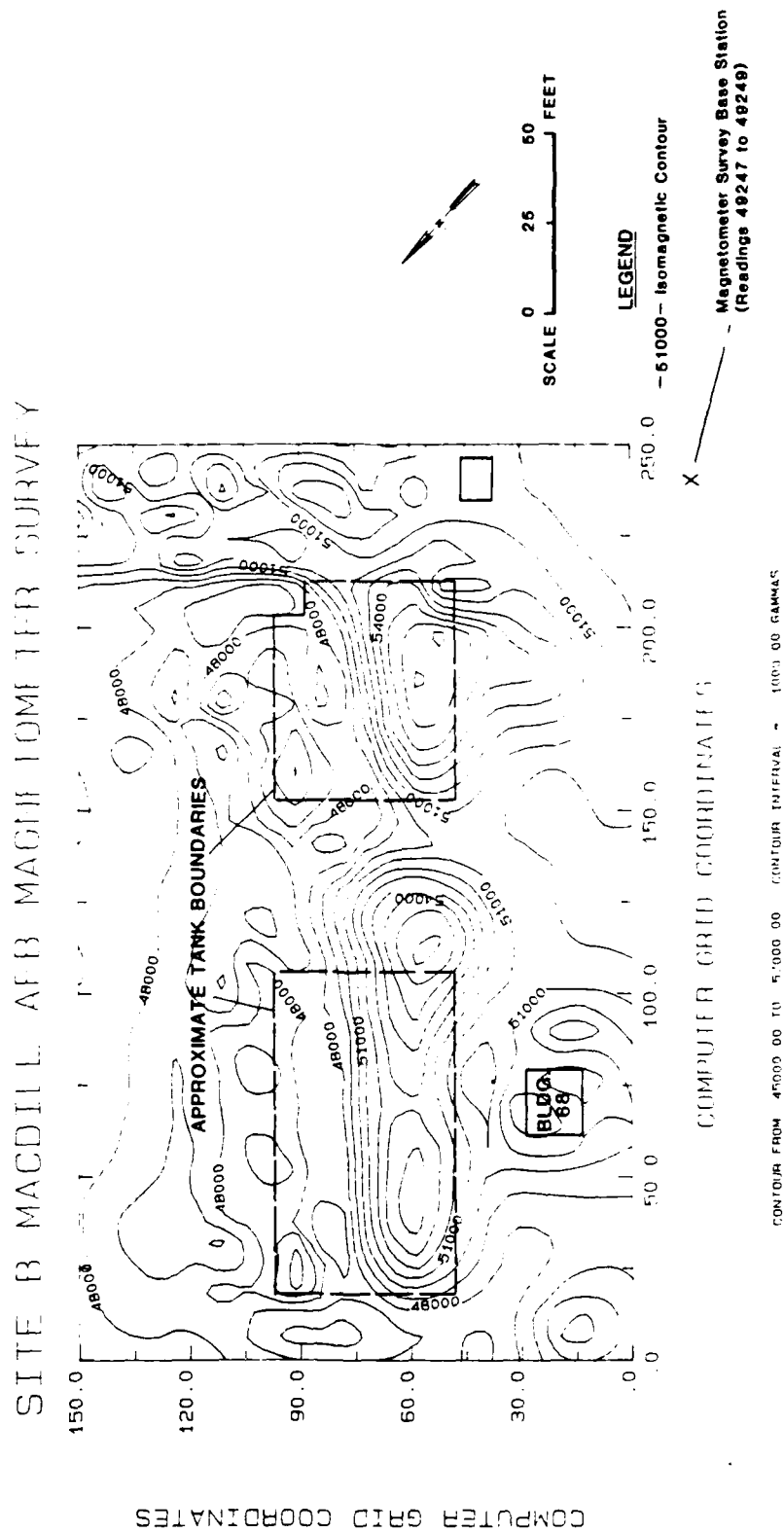
SITE B MACDILL AFB MAGNETOMETER SURVEY STATION LOCATION



COMPUTER GRID COORDINATES

FIGURE F.3

FIGURE F.4



are taken from the construction diagram of the site. The magnetic survey reveals two anomalously high areas which lie slightly southwest of the expected boundaries. The high values are shifted slightly southwest due to a heading factor (see Page F-5) such that the boundaries of the two sets of fuel tanks are nearly identical to those determined by the cable-metal detector and construction diagram. The values at the magnetometer base station varied from 49,247 to 49,249 gammas and readings were taken at the base station throughout the survey of Site B to assure consistent data.

Resistivity Survey

The resistivity survey at Site B consisted of both soundings and profiles. Figure F.5 shows the locations of the sounding and profile stations. The sounding at Site B was conducted along the northeast boundary of the site along Short Cut Road to a depth of 60 feet. The apparent resistivity values are plotted versus the potential electrode spacing (depth below ground surface) on Figure F.6. The sounding did not confirm the suspected subsurface stratigraphy and geologic interpretation is based upon subsequent well installation. Table F.1 summarizes the data from which the sounding graph was generated.

Profiles at Site B consisted of electrode spacings of 5, 10, 20, and 30 feet. These spacings were chosen to fully penetrate the surficial sand deposit which, based upon previous boring logs around the base, extends to approximately 20 feet below ground surface. The five-foot ER profile map (Figure F.7) indicates anomalously low resistivity values to the south and southwest of the southeastern tank cluster. The 10-foot ER profile map (Figure F.8) also indicates low resistivity values in the same region. The 20 and 30-foot ER profile maps (Figure F.9 and F.10) indicate no extensive anomalous pattern. The low values registered at profile station P-6 (Figure F.5) on both the 20 and 30-foot ER profile maps may have been affected by buried water and fuel lines (see Figure F.5). The lines only affected the deeper profiles because the array is spread out much further for deeper investigations. The electrodes may have been placed too close to the lines and prohibited a complete circuit, resulting in erroneously low resistivity values.

FIGURE F.5

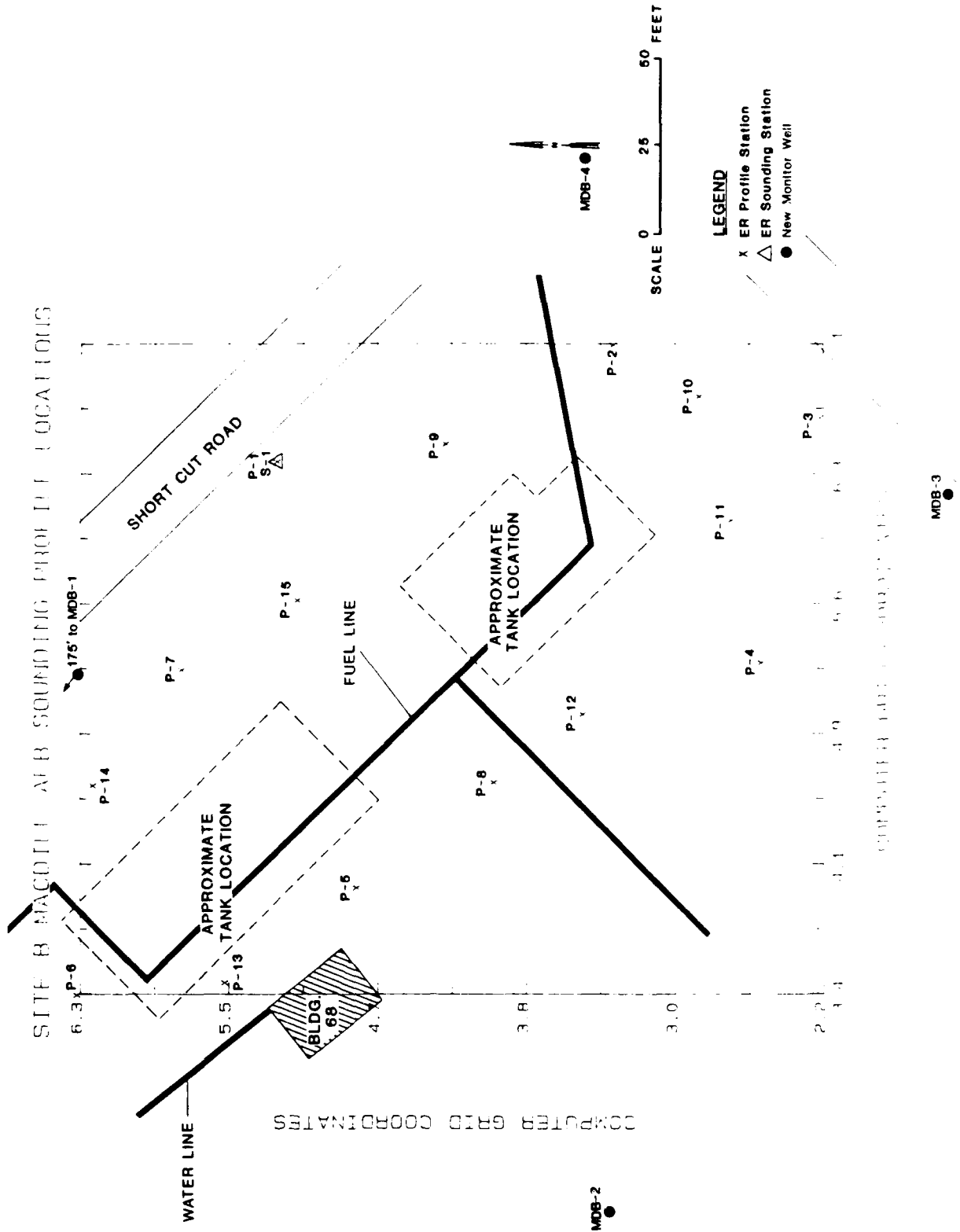
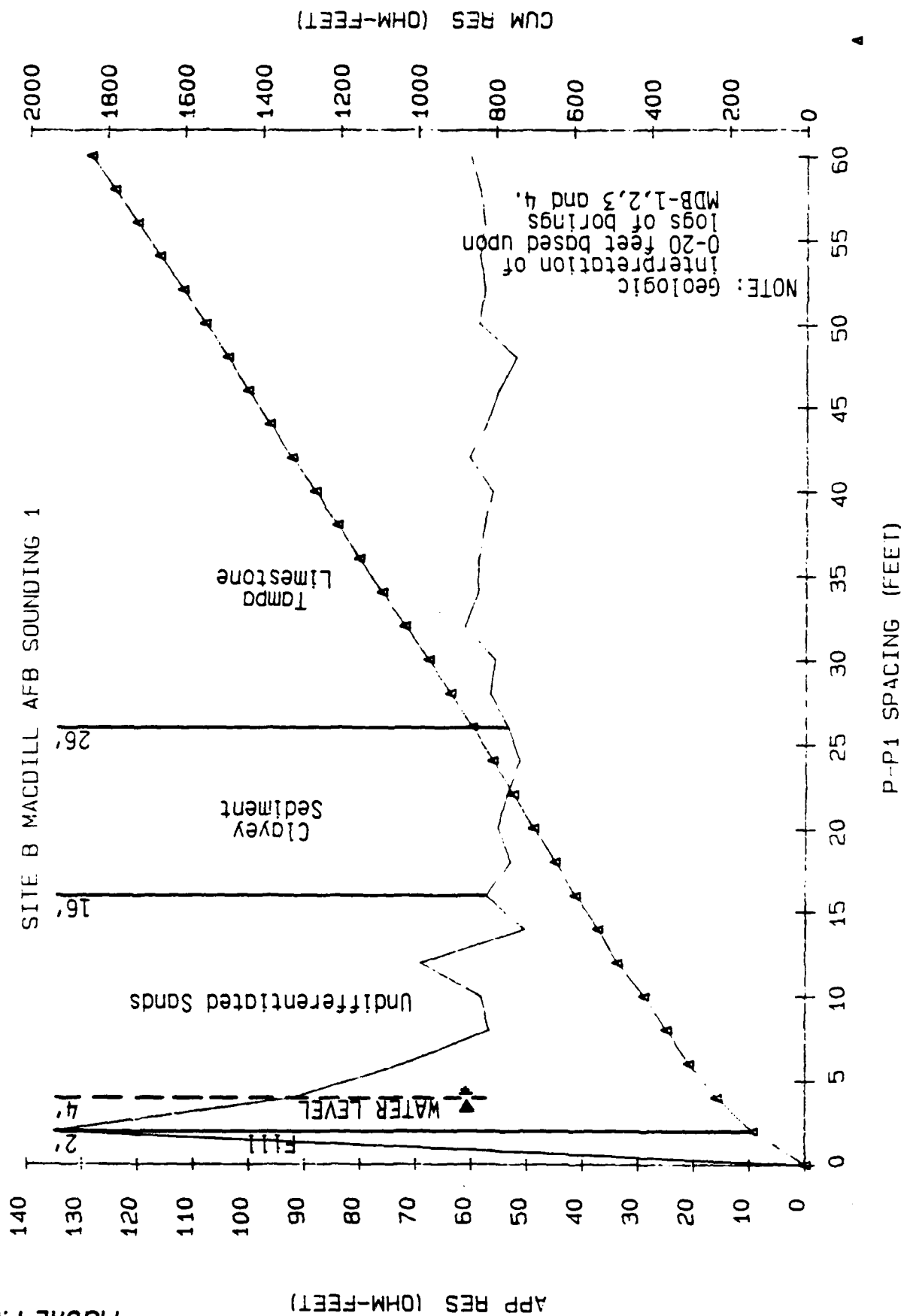


FIGURE F.6



Anomalously low resistivity values at Site B existed south and southwest of the southeastern tank cluster at depths of 5 and 10 feet. Well MDB-3 was located to investigate these low values. Since no other extensive anomalous patterns were detected at the site, wells MDB-2 and MDB-4 were located in opposite corners downgradient of the site. The downgradient direction was determined from surface water drainage features and topography. Groundwater flow direction was estimated to be south to southeast. Well MDB-1 was located as an upgradient well based upon this estimated flow direction.

F.2.2 Site No. 3 (Landfill at Dog Kennel)

Resistivity Survey

The resistivity survey at Site 3 consisted of both soundings and profiles. Figure F.11 shows the locations of the sounding and profile stations. The sounding at Site 3 was conducted to a depth of 60 feet north of Southshore Road near the munitions storage facility. Figure F.12 is the graph of the sounding and correlation with existing well log data from Site 3. The sounding confirmed the presence of three distinct subsurface units which correlated with subsequent well log data. Table F.2 summarizes the data from which the sounding curve was generated.

The profile measurements obtained at Site 3 consisted of profiles at electrode spacings of 5, 10, 20 and 30 feet. The five-foot ER profile map (Figure F.13) indicates low resistivity values along the western and southwestern drainage ditches. There are also two points, P-10 and P-11 (see Figure F.11 for location), which are isolated low values near well MD3-3. The 10-foot ER profile map (Figure F.14) indicates low resistivity values in the same general areas as indicated by the five foot profile depth. The low values located near well MD3-3 are further west, nearer the well. The 20-foot ER profile map (Figure F.15) indicates relatively low resistivity values in the same general areas as in the 5 and 10 foot profiles. The values at a depth of 20 feet are not as low, relative to surrounding values, as those in the 5 and 10 foot profiles. The 30-foot ER profile map (Figure F.16) again indicates two low resistivity zones in the same general areas as in the shallower profiles. The low values at a depth of 30 feet are reduced in area and similar to the surrounding values.

TABLE F.1
SITE B SOUNDING
MACDILL AFB

p-pl spacing (feet)	dial reading (ohms)	scale multiplier	corrected reading (ohms)	k (feet)	apparent resistivity (ohm-ft)	cumulative resistivity (ohm-ft)
2.00	54.00	0.001	0.0540	2499.80	134.99	134.99
4.00	73.50	0.001	0.0735	1249.50	91.84	226.83
6.00	86.50	0.001	0.0865	832.60	72.02	298.85
8.00	91.00	0.001	0.0910	624.00	56.78	355.63
10.00	117.00	0.001	0.1170	498.80	58.36	413.99
12.00	166.50	0.001	0.1665	415.20	69.13	483.12
14.00	142.00	0.001	0.1420	355.40	50.47	533.59
16.00	185.00	0.001	0.1850	310.50	57.44	591.03
18.00	192.50	0.001	0.1925	275.50	53.03	644.06
20.00	223.50	0.001	0.2235	247.50	53.32	699.38
22.00	239.00	0.001	0.2390	224.50	53.66	753.04
24.00	250.50	0.001	0.2505	205.30	51.43	804.46
26.00	283.00	0.001	0.2830	189.10	53.52	857.98
28.00	324.50	0.001	0.3245	175.10	56.82	914.80
30.00	343.00	0.001	0.3430	162.90	55.87	970.67
32.00	403.50	0.001	0.4035	152.30	61.45	1032.13
34.00	413.00	0.001	0.4130	142.80	58.98	1091.10
36.00	438.00	0.001	0.4380	134.40	58.87	1149.97
38.00	457.00	0.001	0.4570	126.80	57.95	1207.92
40.00	470.00	0.001	0.4700	120.00	56.40	1264.32
42.00	533.50	0.001	0.5335	113.80	60.71	1325.03
44.00	533.00	0.001	0.5330	108.10	57.62	1382.65
46.00	538.00	0.001	0.5380	102.90	55.36	1438.01
48.00	531.00	0.001	0.5310	98.20	52.14	1490.15
50.00	629.00	0.001	0.6290	93.80	59.00	1549.15
52.00	646.50	0.001	0.6465	89.70	57.99	1607.14
54.00	686.50	0.001	0.6865	85.80	58.90	1666.05
56.00	705.00	0.001	0.7050	82.30	58.02	1724.07
58.00	746.00	0.001	0.7460	79.00	58.93	1783.00
60.00	801.00	0.001	0.8010	75.80	60.72	1843.72

CORRECTED READING = DIAL READING * SCALE MULTIPLIER = $2\pi V/I$
 $k = 1/[(1/r_1) - (1/r_2) - (1/r_3) + (1/r_4)]$
 APPARENT RESISTIVITY = $2\pi V/I * k$

FIGURE F.7

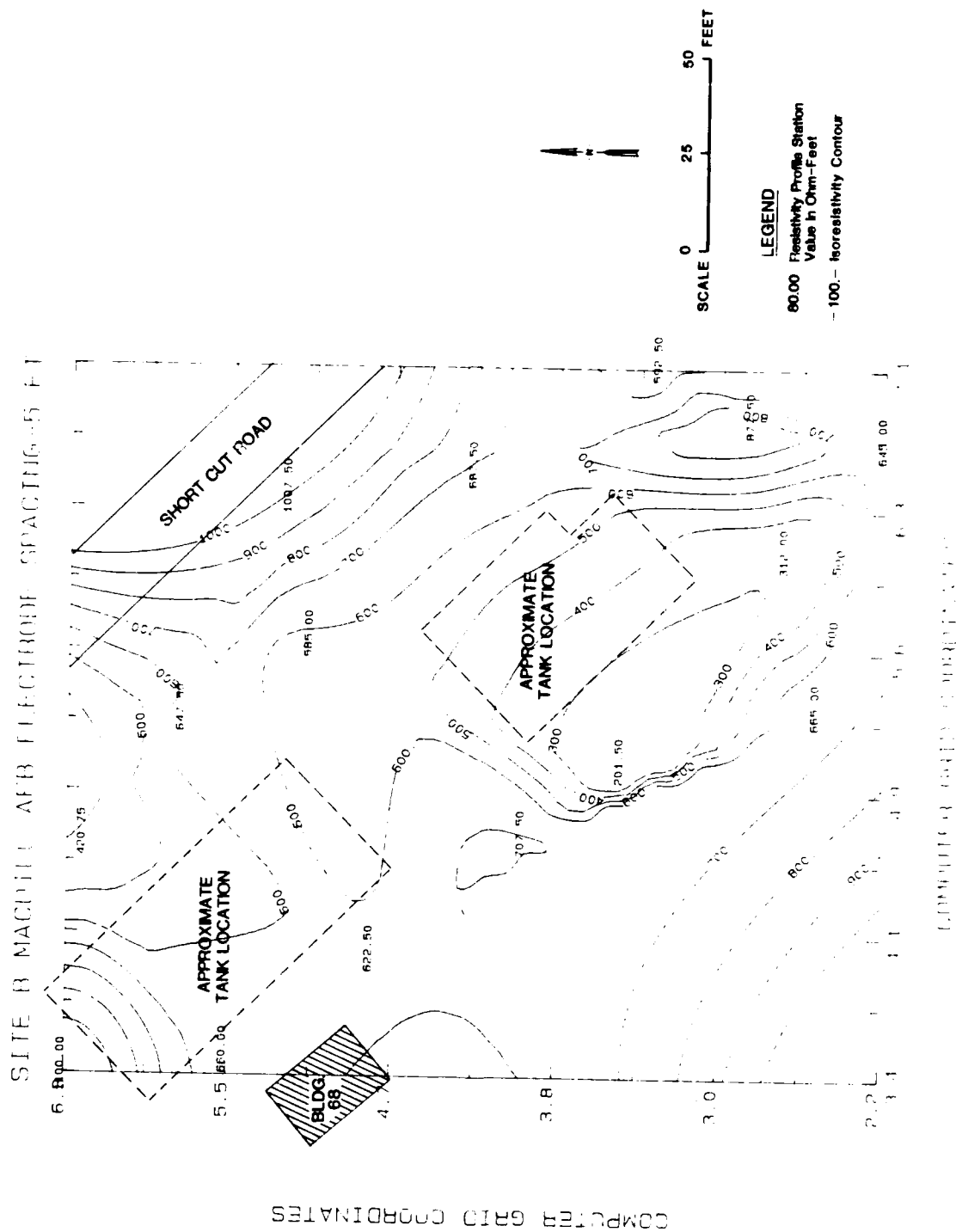


FIGURE F.8

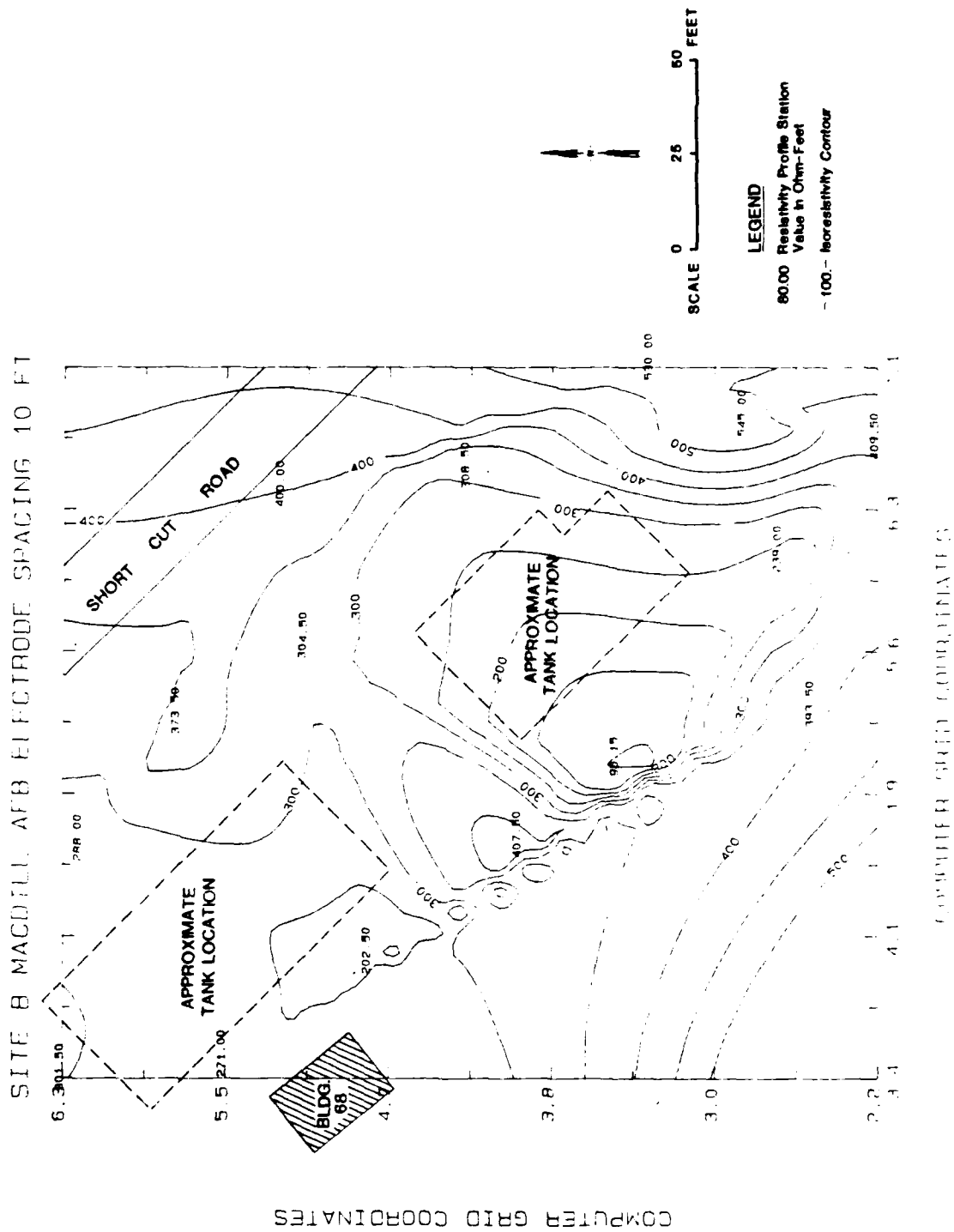


FIGURE F.9

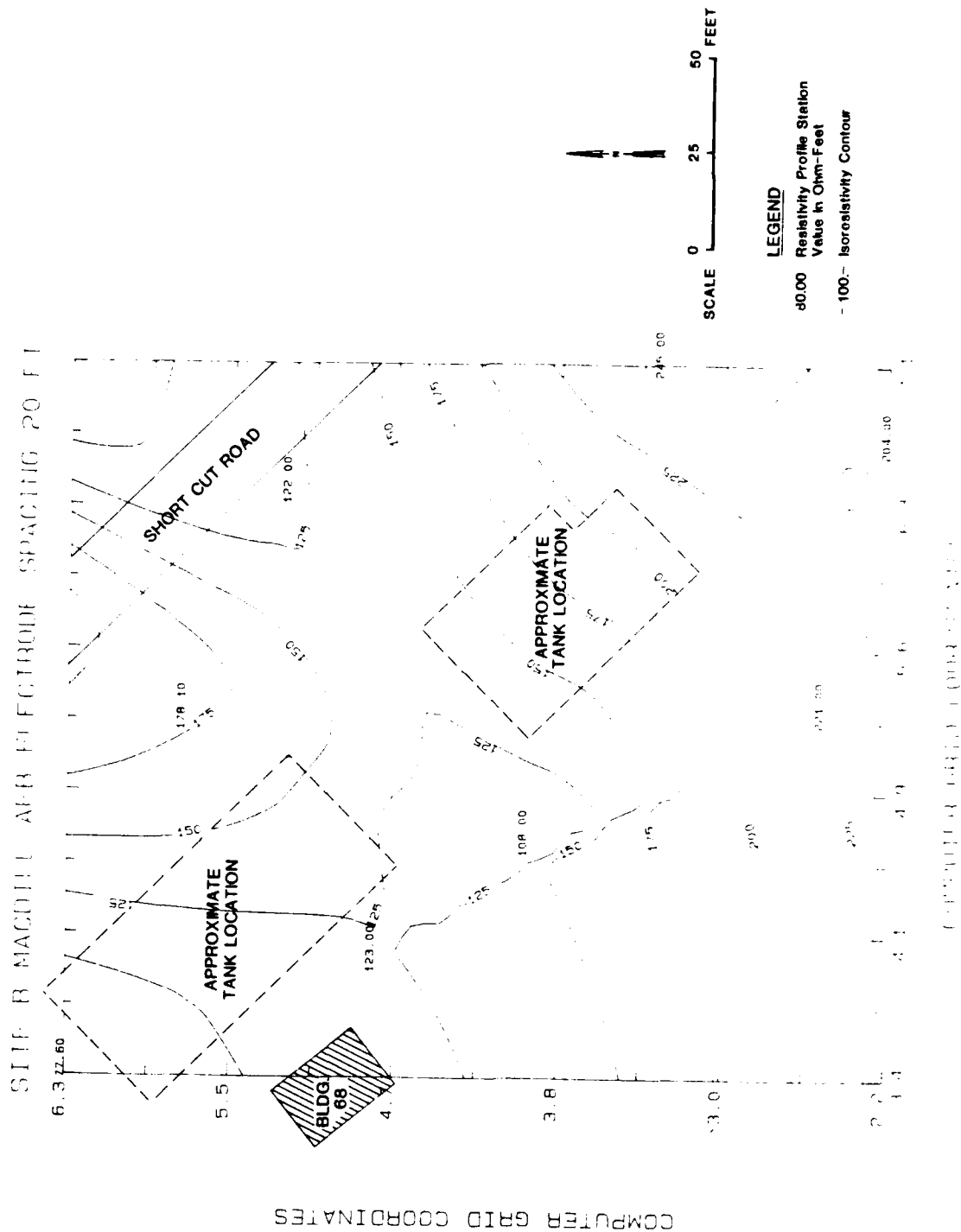


FIGURE F.10

SITE B MACDILL AFB ELFCIROOF SPACING--30 FT

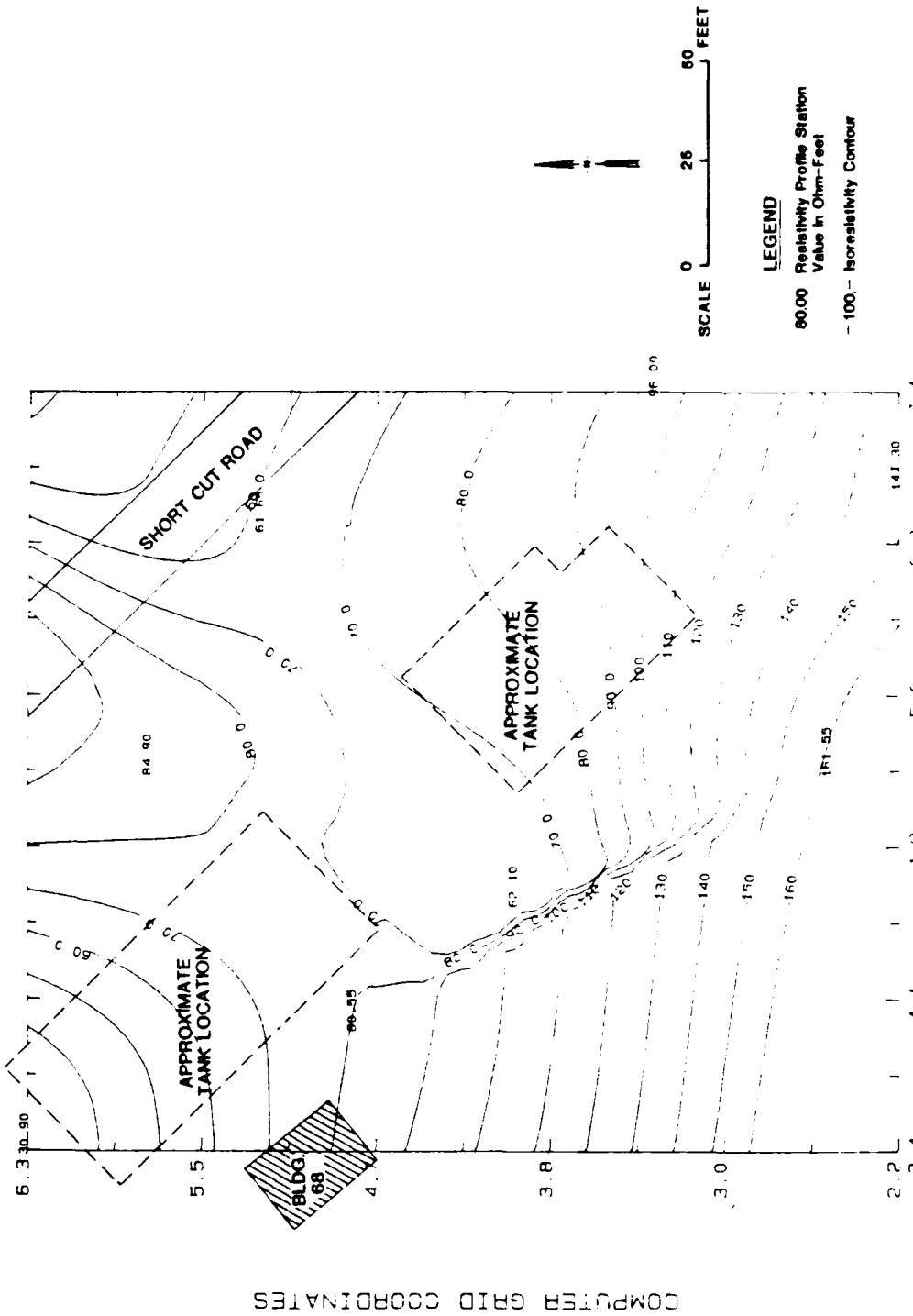


FIGURE F.11

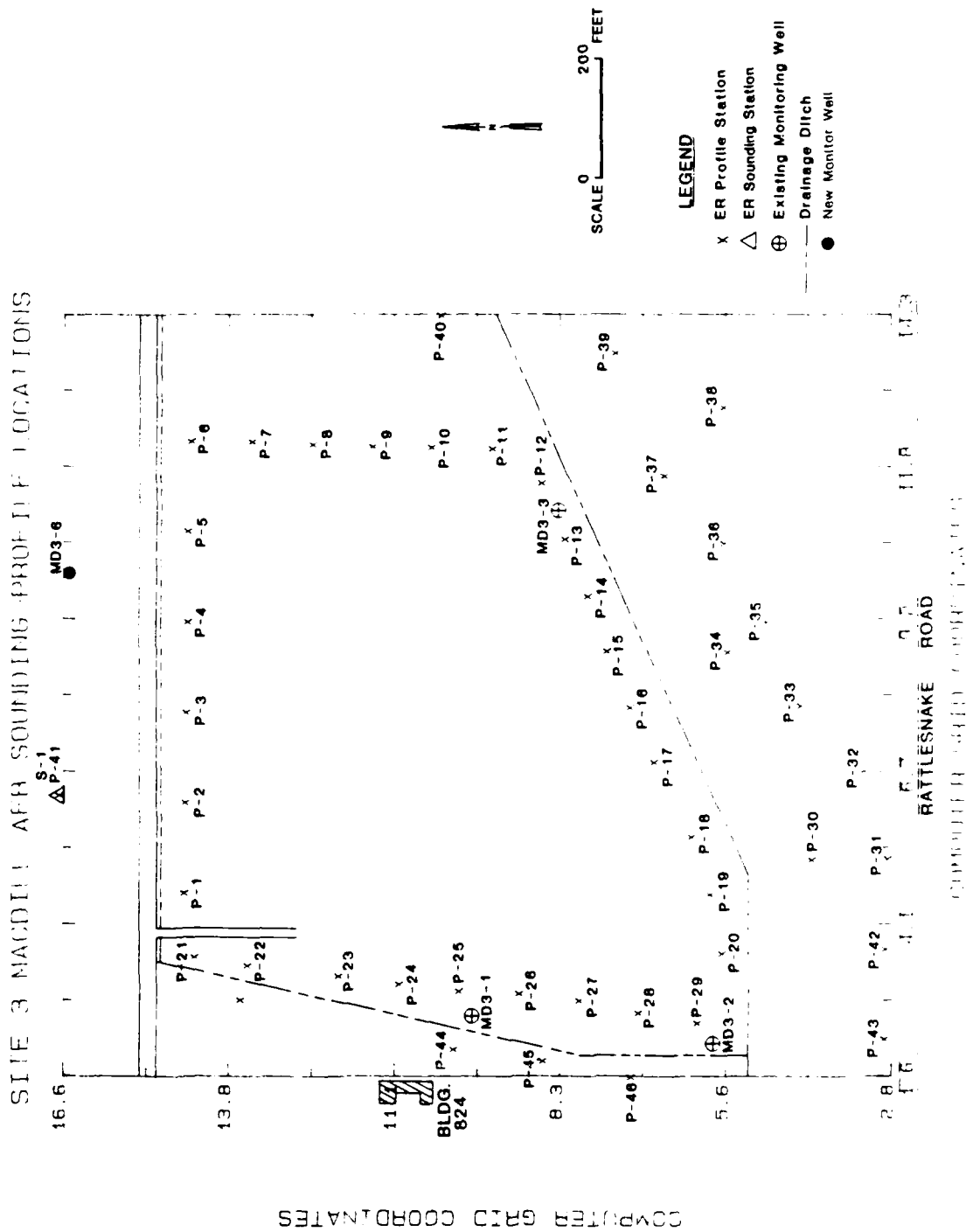


FIGURE F.12

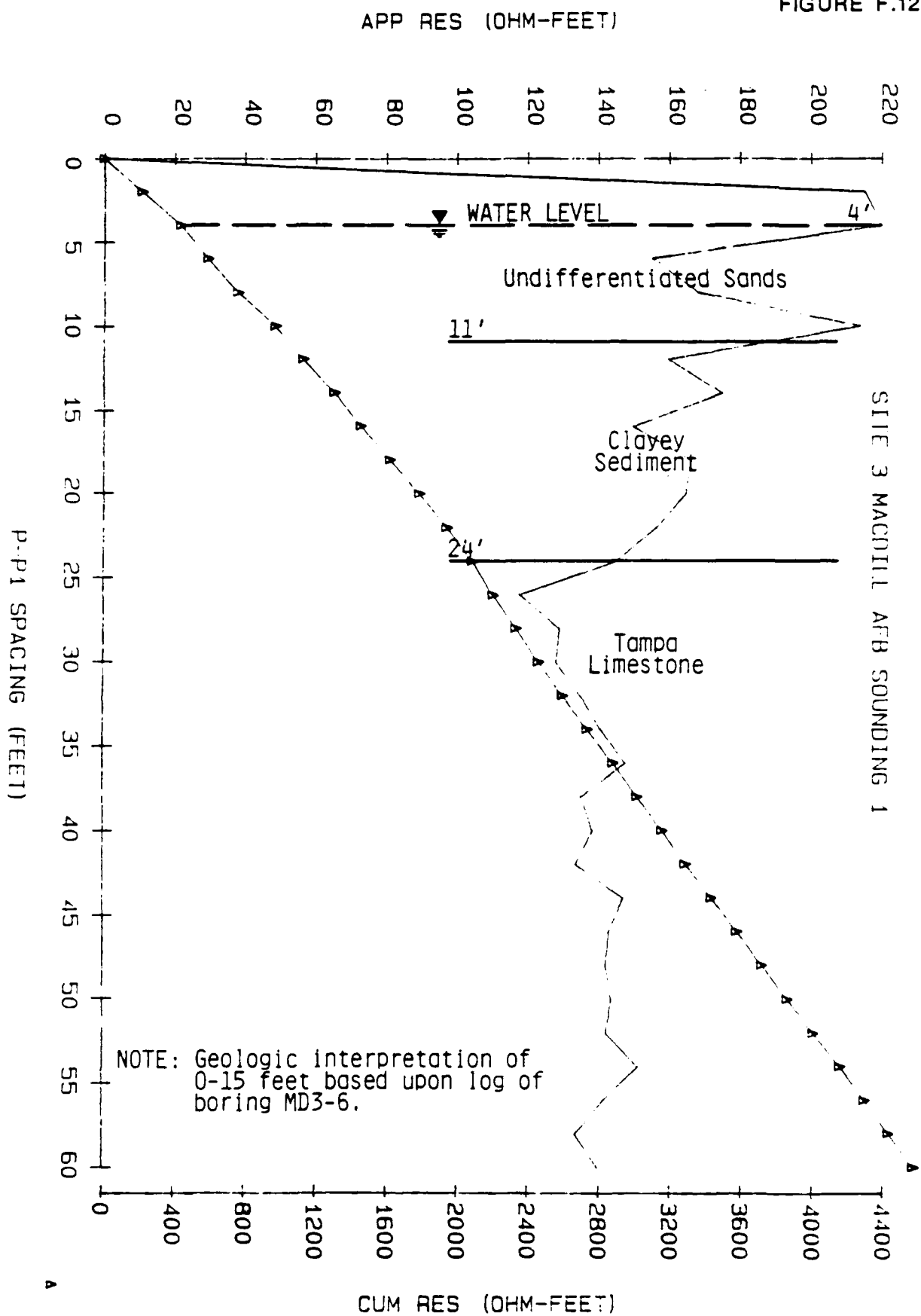


TABLE F.2
SITE 3 SOUNDING 1
MACDILL AFB

p-p1 spacing (feet)	dial reading (ohms)	scale multiplier	corrected reading (ohms)	k (feet)	apparent resistivity (ohm-ft)	cumulative resistivity (ohm-ft)
2.00	239.00	0.001	0.2390	899.80	215.05	215.05
4.00	489.00	0.001	0.4890	449.50	219.81	434.86
6.00	518.00	0.001	0.5180	299.30	155.04	589.90
8.00	749.50	0.001	0.7495	224.00	167.89	757.78
10.00	119.50	0.010	1.1950	178.80	213.67	971.45
12.00	107.50	0.010	1.0750	148.50	159.64	1131.09
14.00	138.00	0.010	1.3800	126.80	174.98	1306.07
16.00	135.50	0.010	1.3550	110.50	149.73	1455.80
18.00	170.00	0.010	1.7000	97.80	166.26	1622.06
20.00	188.00	0.010	1.8800	87.50	164.50	1786.56
22.00	197.50	0.010	1.9750	79.10	156.22	1942.78
24.00	201.00	0.010	2.0100	72.00	144.72	2087.50
26.00	168.00	0.010	1.6800	70.00	117.60	2205.10
28.00	212.00	0.010	2.1200	60.80	128.90	2334.00
30.00	227.00	0.010	2.2700	56.30	127.80	2461.80
32.00	258.00	0.010	2.5800	52.30	134.93	2596.73
34.00	289.00	0.010	2.8900	48.70	140.74	2737.47
36.00	324.50	0.010	3.2450	45.50	147.65	2885.12
38.00	317.00	0.010	3.1700	42.60	135.04	3020.16
40.00	346.00	0.010	3.4600	40.00	138.40	3158.56
42.00	355.00	0.010	3.5500	37.60	133.48	3292.04
44.00	415.50	0.010	4.1550	35.40	147.09	3439.13
46.00	427.50	0.010	4.2750	33.40	142.79	3581.92
48.00	450.50	0.010	4.5050	31.50	141.91	3723.82
50.00	482.00	0.010	4.8200	29.80	143.64	3867.46
52.00	505.00	0.010	5.0500	28.10	141.91	4009.36
54.00	568.00	0.010	5.6800	26.60	151.09	4160.45
56.00	562.50	0.010	5.6250	25.10	141.19	4301.64
58.00	560.00	0.010	5.6000	23.80	133.28	4434.92
60.00	621.50	0.010	6.2150	22.50	139.84	4574.76

CORRECTED READING = DIAL READING * SCALE MULTIPLIER = $2\pi V/I$
 $k = 1/[(1/r1)-(1/r2)-(1/r3)+(1/r4)]$
 APPARENT RESISTIVITY = $2\pi V/I * k$

FIGURE F.13

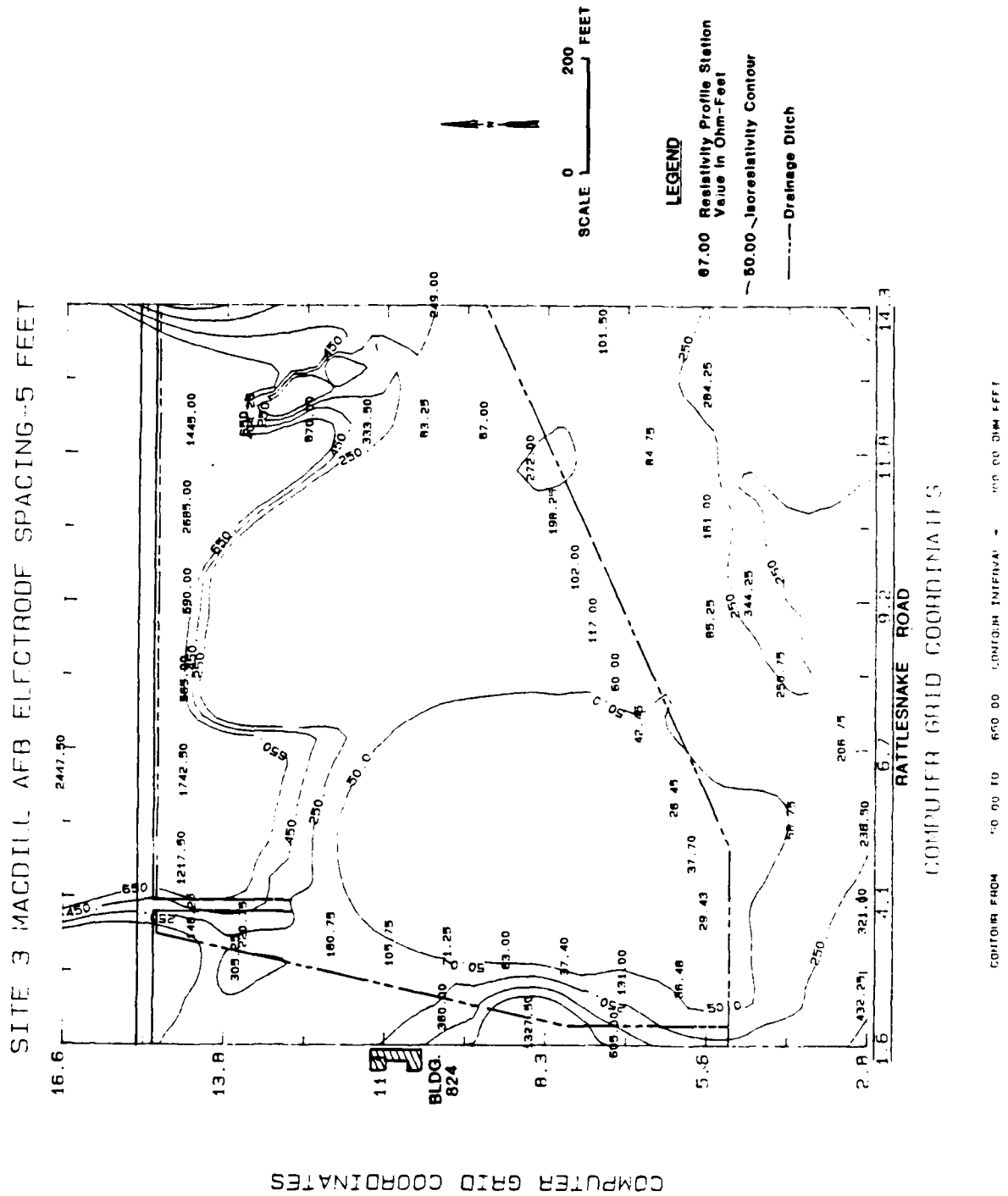
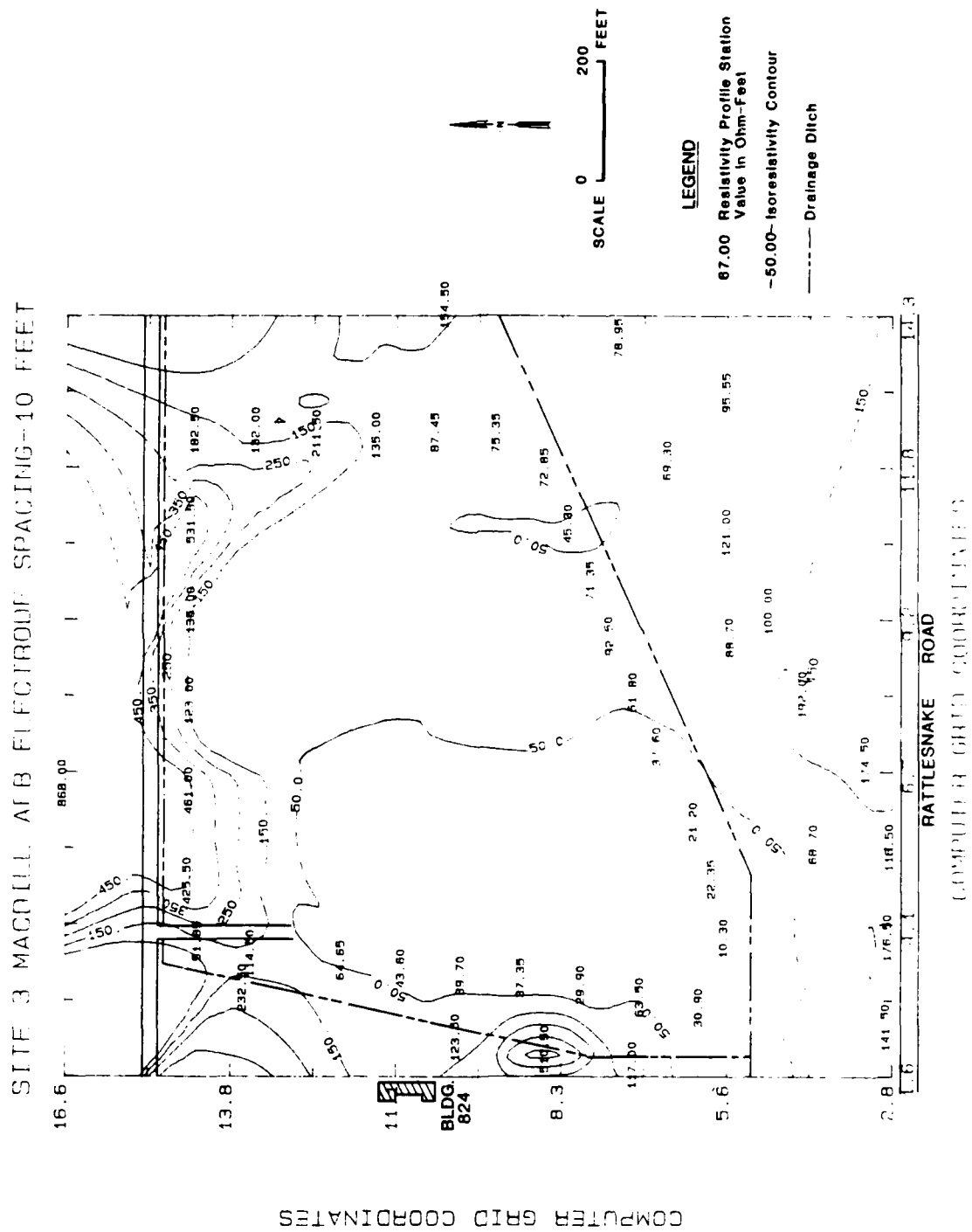


FIGURE F.14



The anomalously low resistivity values at Site 3 existed along the drainage ditches west and south of the site. The ditches are tidally influenced and contain brackish water of high conductivity (see Section 4 for field conductivity measurements). The low resistivity values are interpreted to be caused by an influx of the brackish water into the soils surrounding the ditches. These low values may mask any resistivity anomalies associated with possible leachate plumes. The ditches and existing wells, however, were sampled during the field investigation to substantiate the areas of low resistivity. The upgradient well MD3-6 was located in an area of higher background resistivity values. The upgradient direction was determined from water level measurements of existing wells completed within the shallow surface aquifer at Site 3.

F.2.3 Site No. 9 (Recent Landfill)

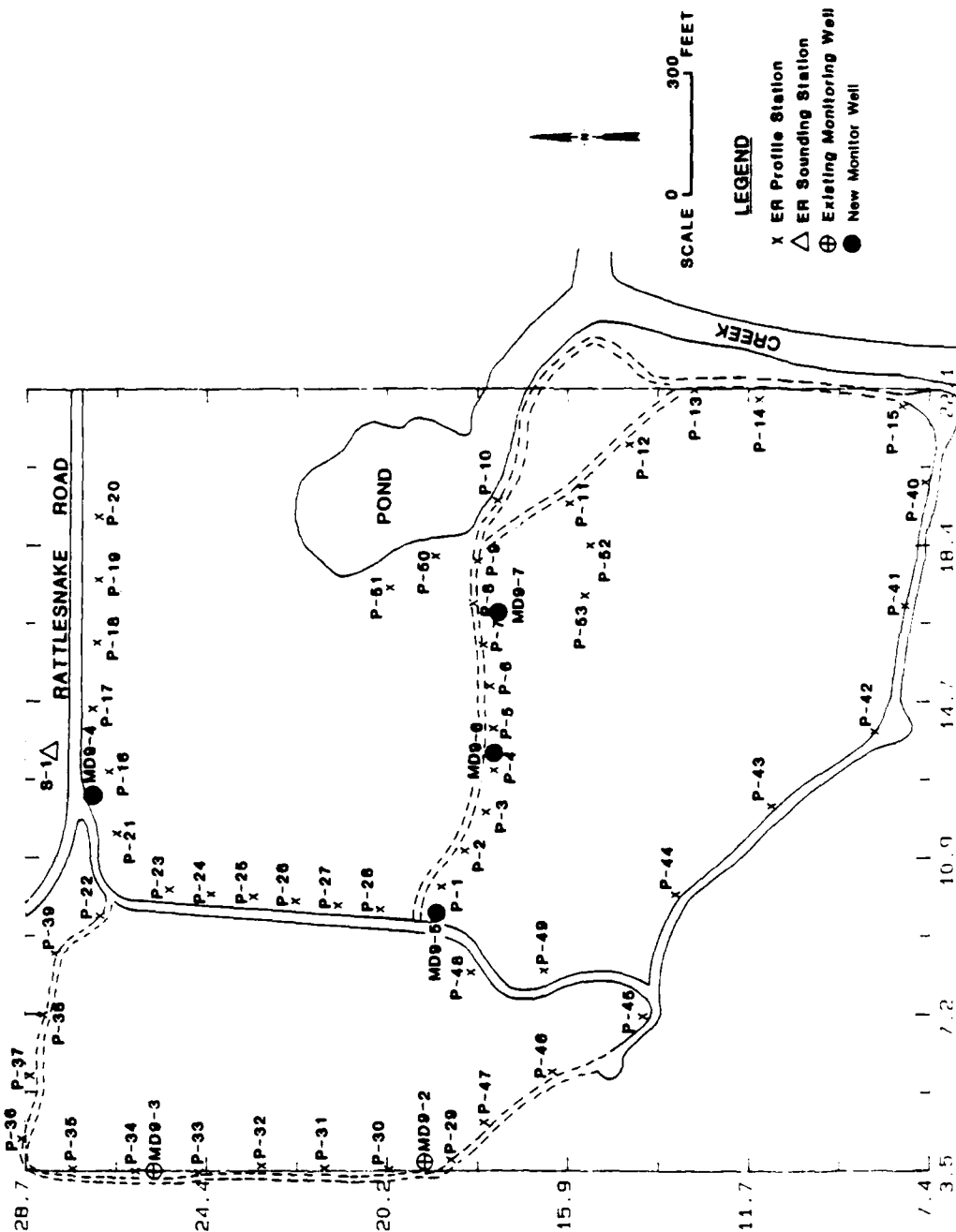
Resistivity Survey

The resistivity survey at Site 9 consisted of both soundings and profiles. Figure F.17 shows the location of the sounding and profile stations. The sounding at Site 9 was conducted to a depth of 60 feet outside the site along Rattlesnake Road. Figure F.18 is the graph of the sounding and is correlated with existing well log data from Site 9. The sounding did not confirm suspected subsurface stratigraphy and geologic interpretation is based upon subsequent well log data. The sounding data is summarized on Table F.3.

The profile measurements obtained at Site 9 consisted of profiles at electrode spacings of 5, 10, 20 and 30 feet. The five-foot ER profile map (Figure F.19) indicates that low resistivity values exist just west of the pond. Low resistivity values also exist along the western border (Broad Creek) where existing monitor wells MD9-1,2 and 3 are located. High resistivity values exist along the southern portion of the road which enters the site at this depth. The 10 foot ER profile map (Figure F.20) also indicates low resistivity values east and south of the pond. The low resistivity values along the western border of the site are also present at this depth. The 20 and 30 foot ER profile maps (Figures F.21 and F.22 respectively) indicate that the resistivity values at these depths are more consistent. Low values still exist in the same general areas as in shallower profiles but are similar to surrounding values.

FIGURE F.17

SITE 9 MACDTIL AFB SOUNDING-PROFILE LOCATIONS



COMPUTER GRID COORDINATES

COMPUTER GRID COORDINATES

FIGURE F.18

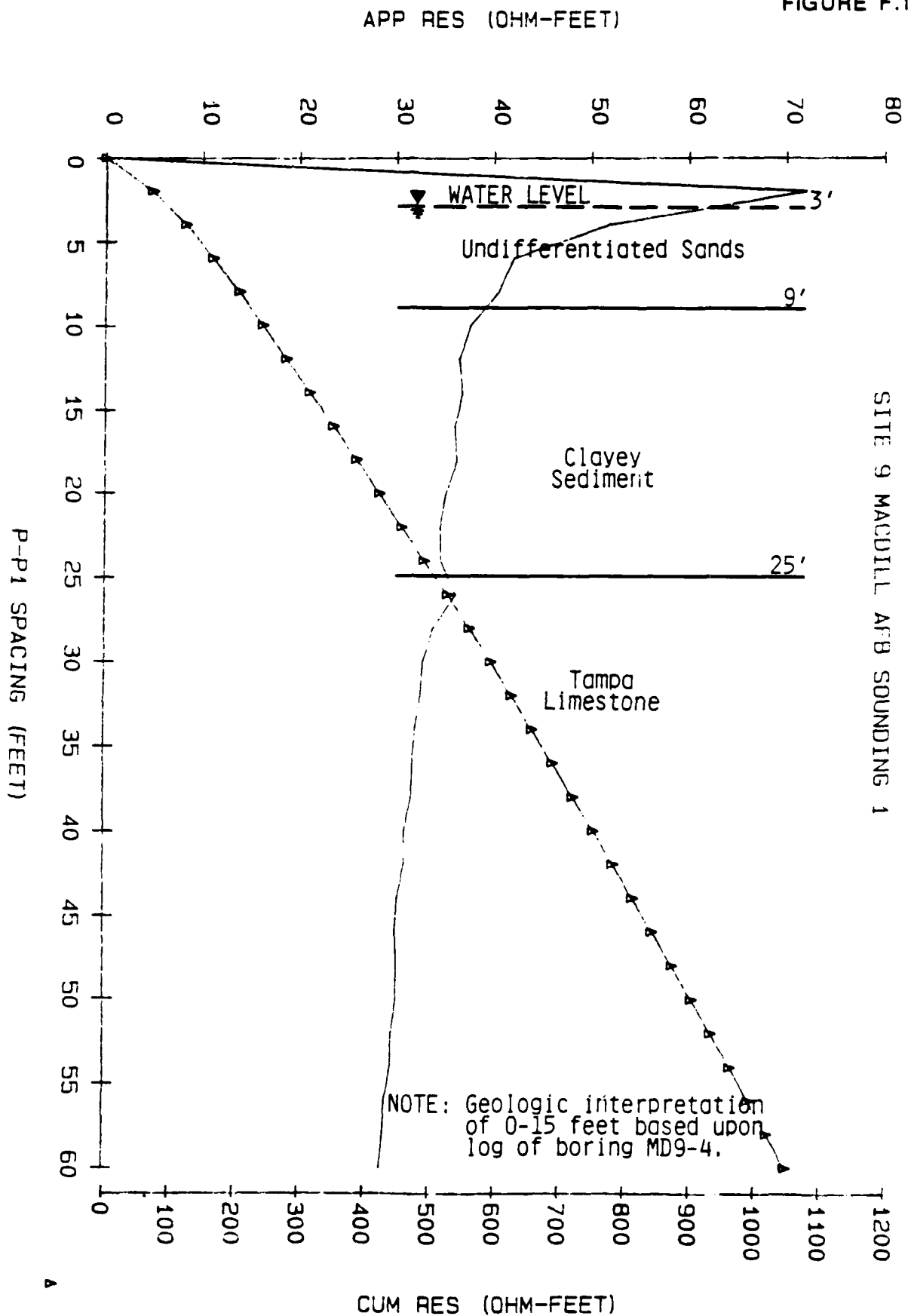


TABLE F.3
SITE 9 SOUNDING 1
MACDILL AFB

p-pi spacing (feet)	dial reading (ohms)	scale multiplier	corrected reading (ohms)	k (feet)	apparent resistivity (ohm-ft)	cumulative resistivity (ohm-ft)
2.00	8.00	0.010	0.0800	899.80	71.98	71.98
4.00	11.50	0.010	0.1150	449.50	51.69	123.68
6.00	14.00	0.010	0.1400	299.30	41.90	165.58
8.00	18.00	0.010	0.1800	224.00	40.32	205.90
10.00	21.00	0.010	0.2100	178.80	37.55	243.45
12.00	24.50	0.010	0.2450	148.50	36.38	279.83
14.00	29.00	0.010	0.2900	126.80	36.77	316.60
16.00	32.50	0.010	0.3250	110.50	35.91	352.51
18.00	37.00	0.010	0.3700	97.80	36.19	388.70
20.00	40.00	0.010	0.4000	87.50	35.00	423.70
22.00	43.50	0.010	0.4350	79.10	34.41	458.11
24.00	48.00	0.010	0.4800	72.00	34.56	492.67
26.00	51.50	0.010	0.5150	70.00	36.05	528.72
28.00	55.50	0.010	0.5550	60.80	33.74	562.46
30.00	58.00	0.010	0.5800	56.30	32.65	595.12
32.00	62.00	0.010	0.6200	52.30	32.43	627.54
34.00	65.50	0.010	0.6550	48.70	31.90	659.44
36.00	69.50	0.010	0.6950	45.50	31.62	691.06
38.00	74.00	0.010	0.7400	42.60	31.52	722.59
40.00	77.00	0.010	0.7700	40.00	30.80	753.39
42.00	82.00	0.010	0.8200	37.60	30.33	784.22
44.00	85.00	0.010	0.8500	35.40	30.09	814.31
46.00	89.50	0.010	0.8950	33.40	29.89	844.20
48.00	95.50	0.010	0.9550	31.50	30.08	874.28
50.00	100.50	0.010	1.0050	29.80	29.95	904.23
52.00	105.00	0.010	1.0500	28.10	29.51	933.74
54.00	110.50	0.010	1.1050	26.60	29.39	963.13
56.00	115.00	0.010	1.1500	25.10	28.87	992.00
58.00	120.50	0.010	1.2050	23.80	28.68	1020.68
60.00	126.00	0.010	1.2600	22.50	28.35	1049.03

CORRECTED READING = DIAL READING * SCALE MULTIPLIER = $2\pi V/I$
 $k = 1/[(1/r1)-(1/r2)-(1/r3)+(1/r4)]$
 APPARENT RESISTIVITY = $2\pi V/I * k$

SITE 9 MACDILL AFB ELECTRODE SPACING--5FT

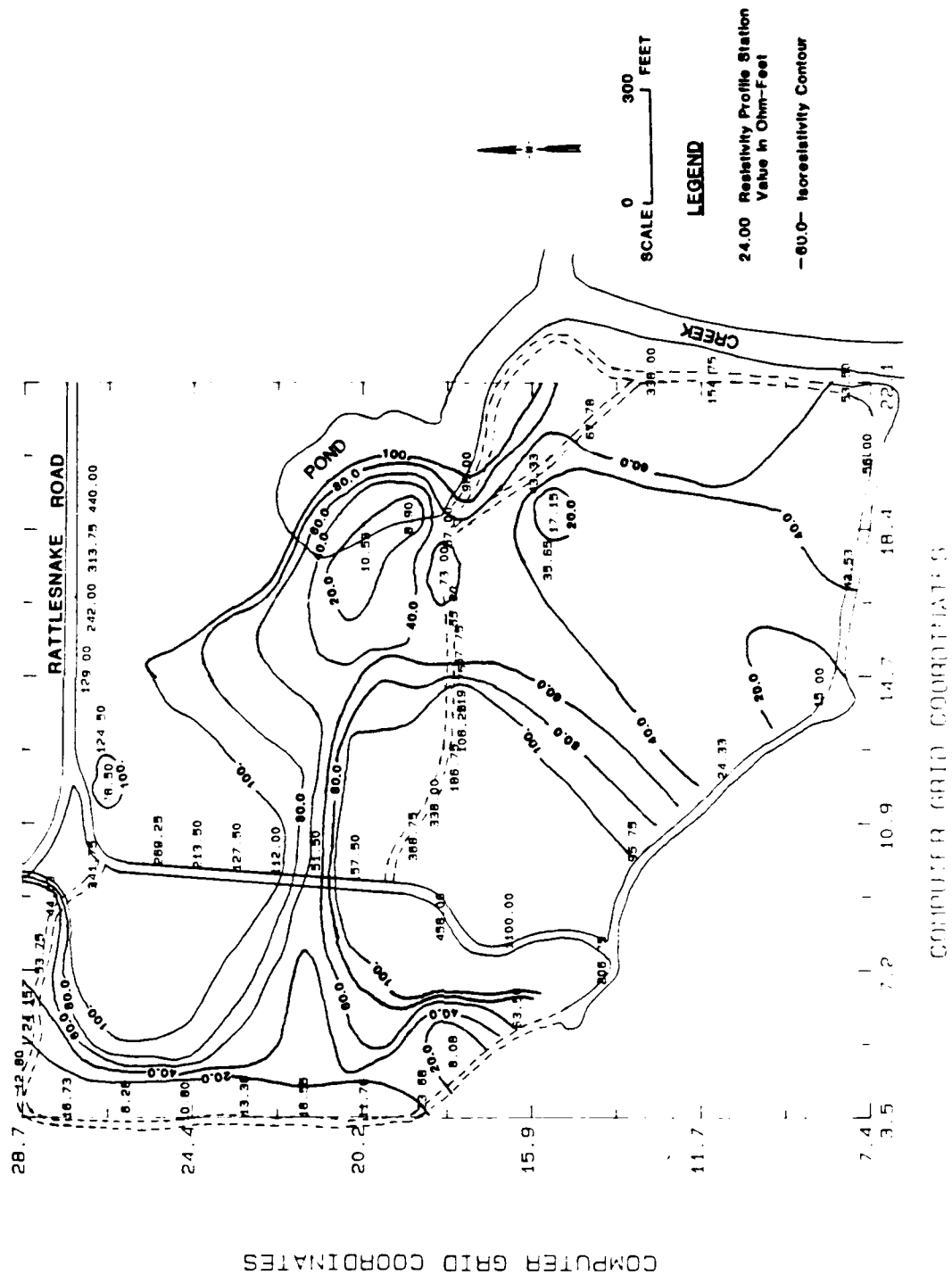
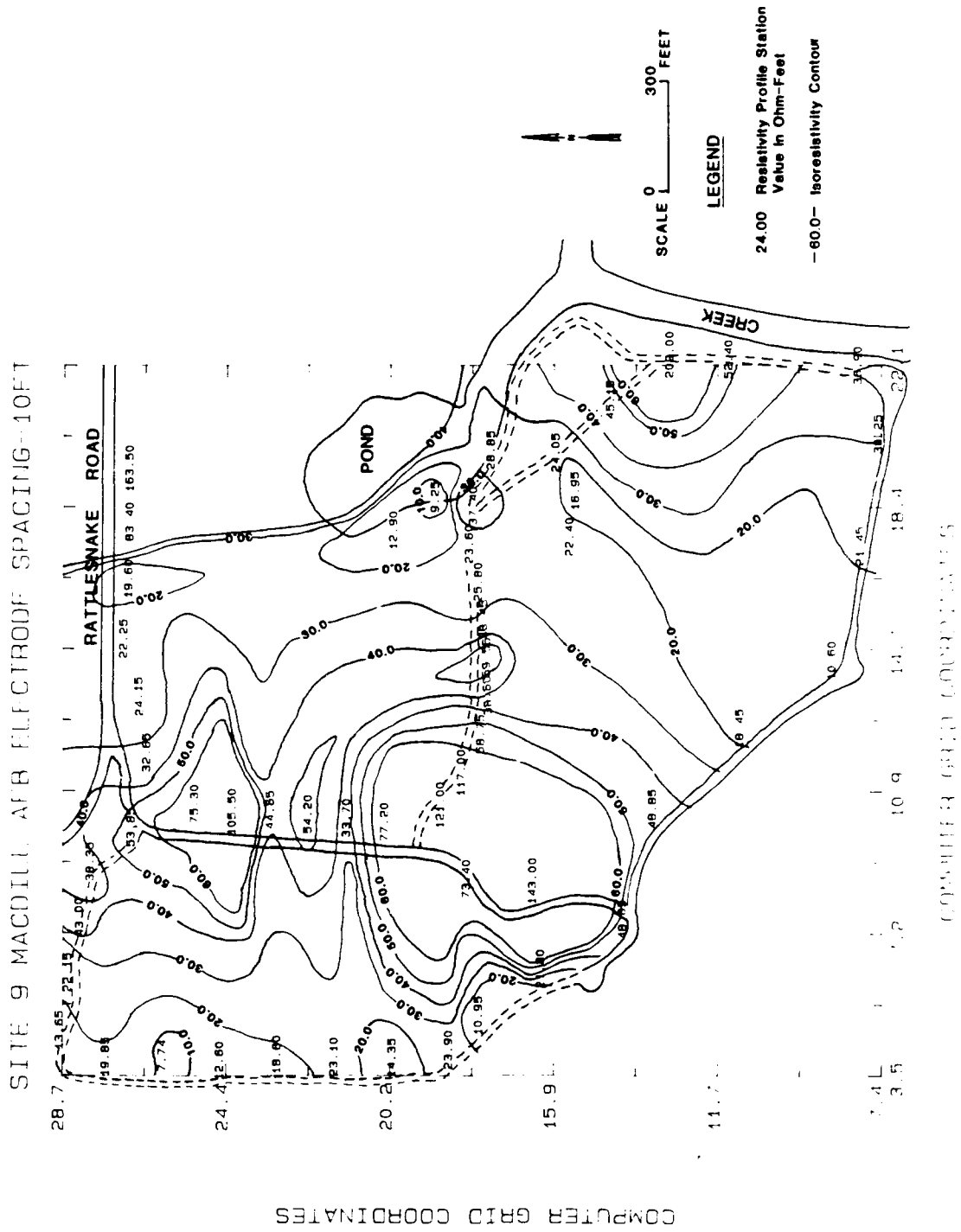


FIGURE F.19

FIGURE F.20



SITE 9 MACDILL AFB ELECTRODE SPACING--20FT

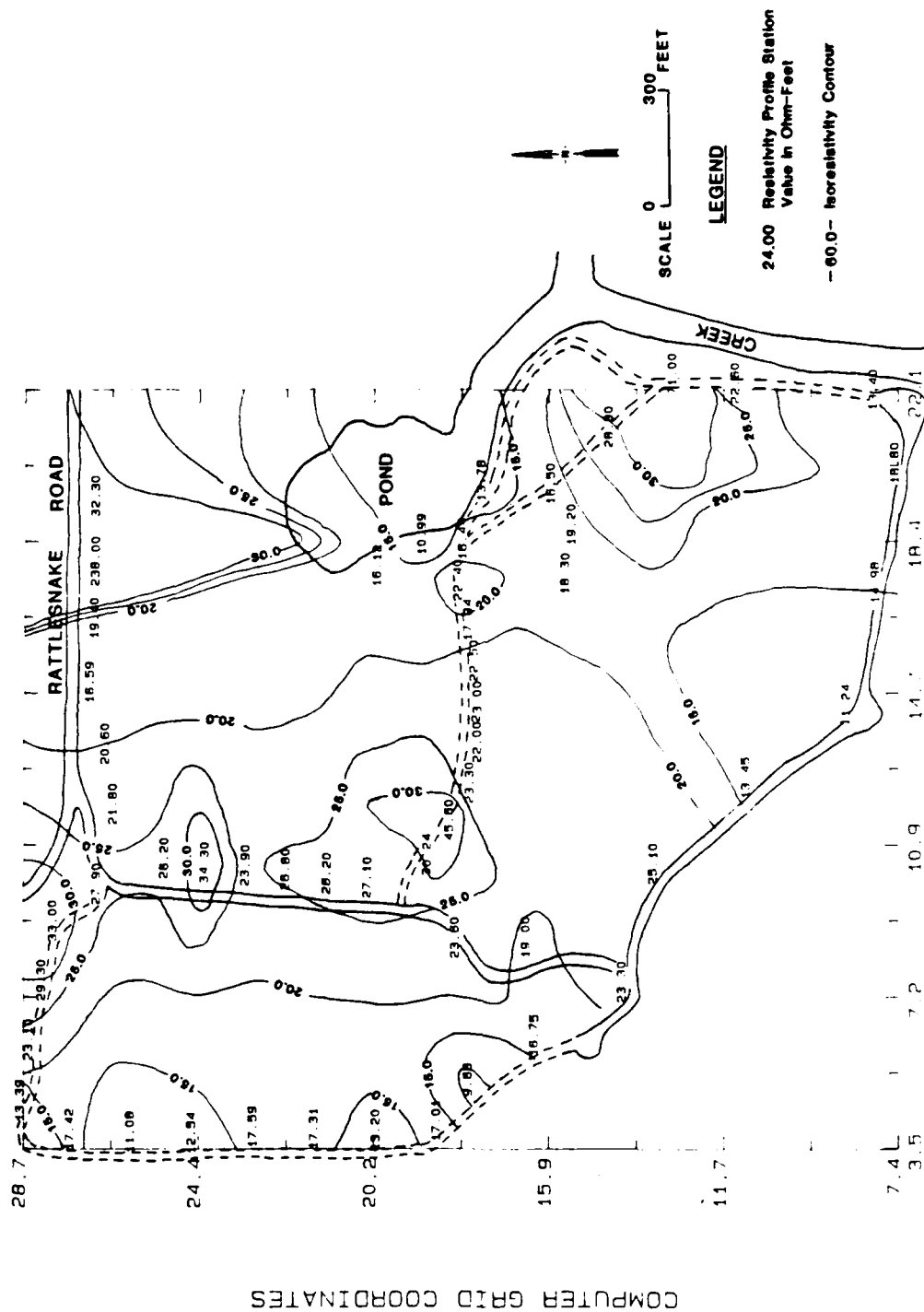


FIGURE F.21

SITE 9 MACDILL AFB ELECTRODE SPACING--30FT

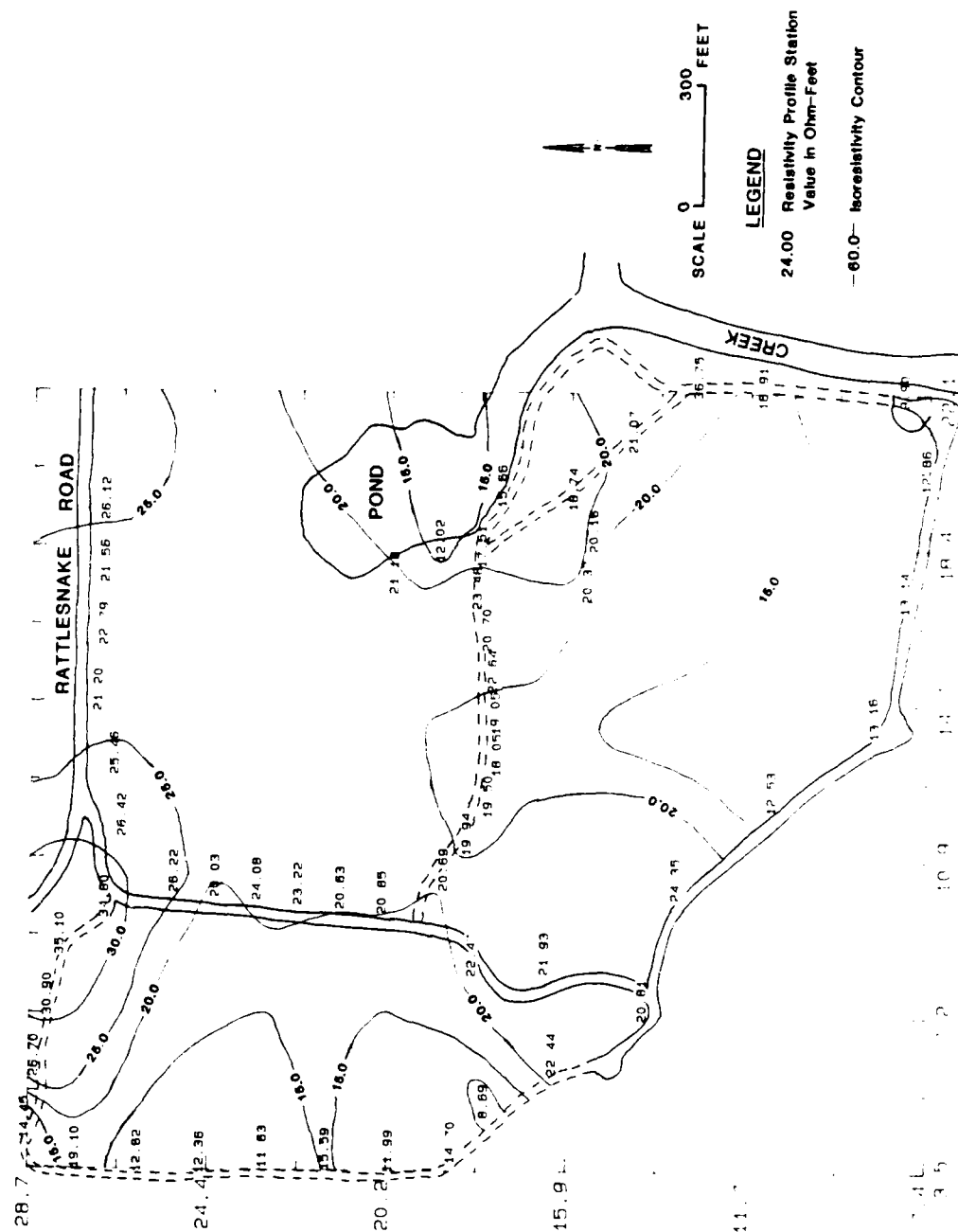


FIGURE F.22

COMPUTER GRID COORDINATES

The anomalously low resistivity values at Site 9 are located along Broad Creek, west and south of the site at depths of 5 and 10 feet. Low resistivity values also exist at these depths, west and south of the pond. Both the creek and the pond are tidally influenced and contain brackish water of high conductivity (see Section 4 for field conductivity measurements). The low resistivity values are interpreted to be due to the influence of the brackish water within the surface sandy sediments. The low values may mask any resistivity anomalies associated with possible leachate plumes and, therefore, the creek and existing wells were chosen as sampling stations during the field investigation. Anomalously high resistivity values at Site 9 existed along the southern portion of the road leading to the site from Rattlesnake Road at depths of 5 to 10 feet. Downgradient wells MD9-5 and MD9-6 were located south of the landfill area within a zone of high resistivity values. Downgradient well MD9-7 was located southwest of the pond in a zone of low resistivity values. The locations of the wells were chosen to be as close to the landfill as possible and downgradient. The upgradient well MD9-4 was located in an area of consistent resistivity values. The downgradient direction was determined from water level measurements of existing wells completed within the shallow surface aquifer at Site 9 and from the investigation conducted by Water and Air Resources, Inc. (Water and Air Resources, 1984).

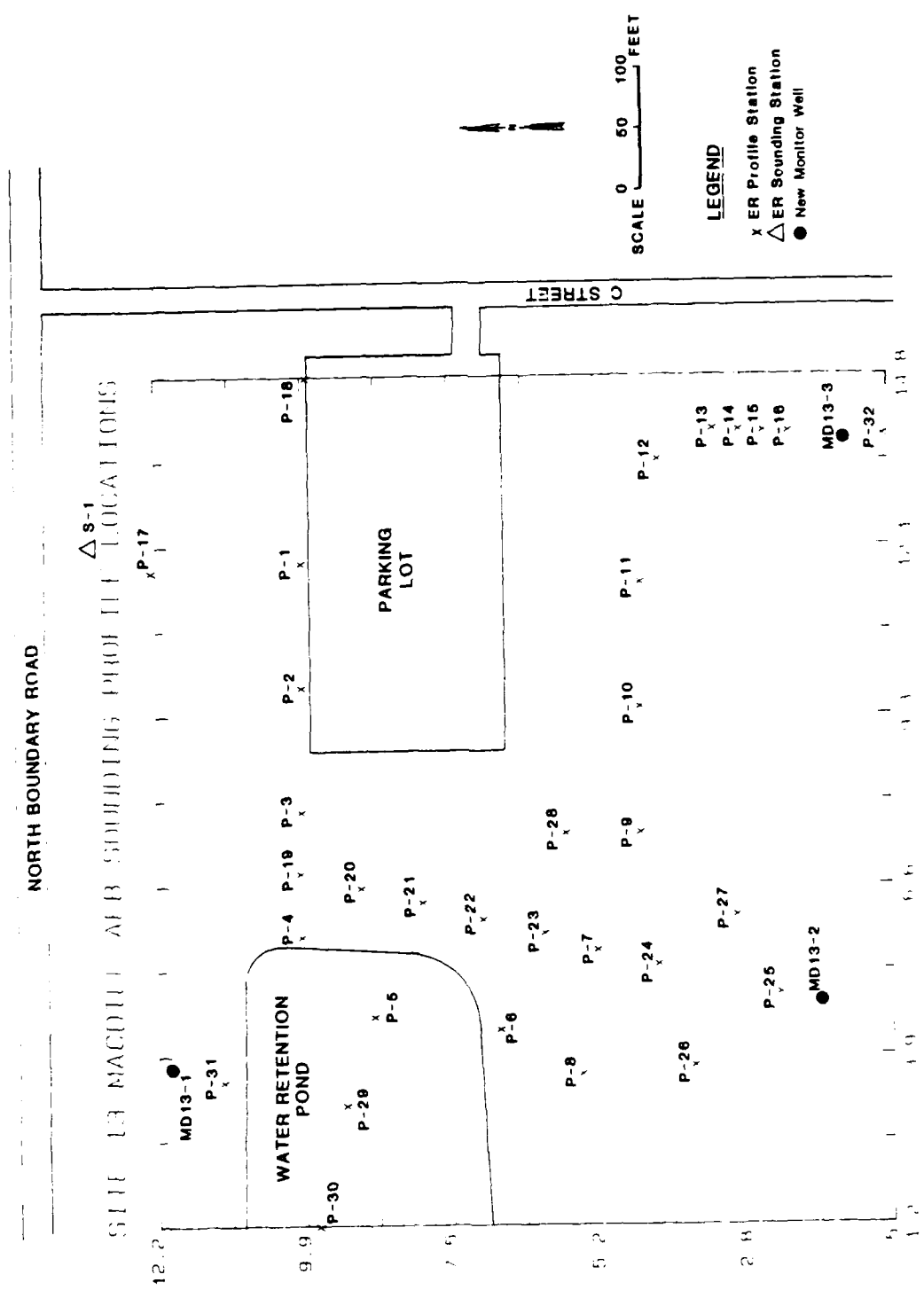
F.2.4 Site No. 13 (Old Creosote Pit)

Resistivity Survey

The resistivity survey at Site 13 consisted of both soundings and profiles. Figure F.23 shows the location of the sounding and profile stations. The sounding at Site 13 was conducted to a depth of 60 feet. Figure F.24 is a graph of the sounding and the interpretation. The sounding did not confirm suspected subsurface stratigraphy and geologic interpretation is based upon subsequent well log data from Site 13 and surrounding sites. The sounding data is summarized on Table F.4.

The profile measurements obtained at Site 13 consisted of profiles at electrode spacings of 5, 10, 20 and 30 feet. The five-foot ER profile map (Figure F.25) indicates low resistivity values located approximately 100 feet southeast of the water retention pond. This anomaly is interpreted to be the possible location of the abandoned creosote pit.

FIGURE F.23



50 40 30 20 10 0 10 20 30 40 50

FIGURE F.24

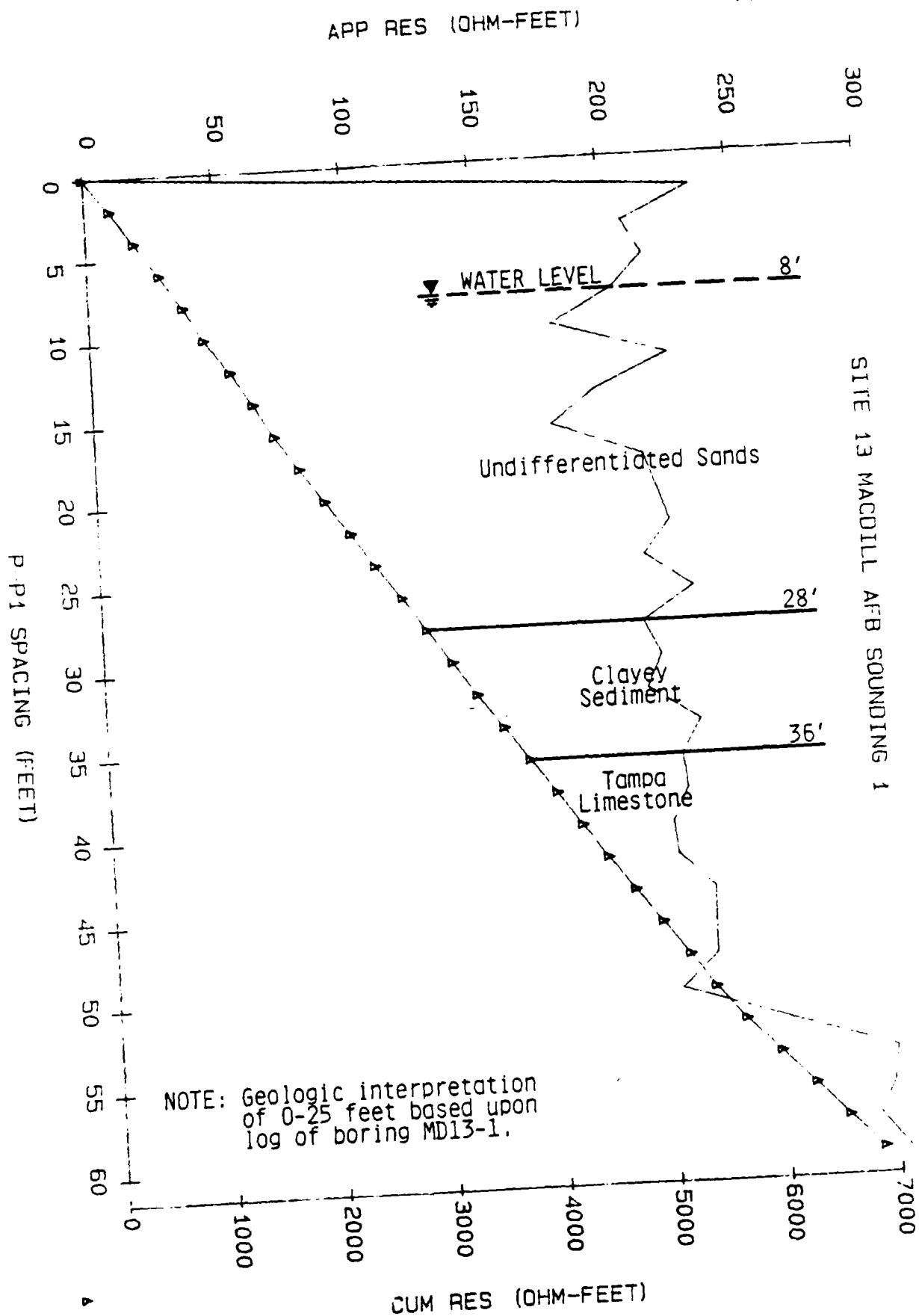


TABLE F.4
SITE 13 SOUNDING 1
MACDILL AFB

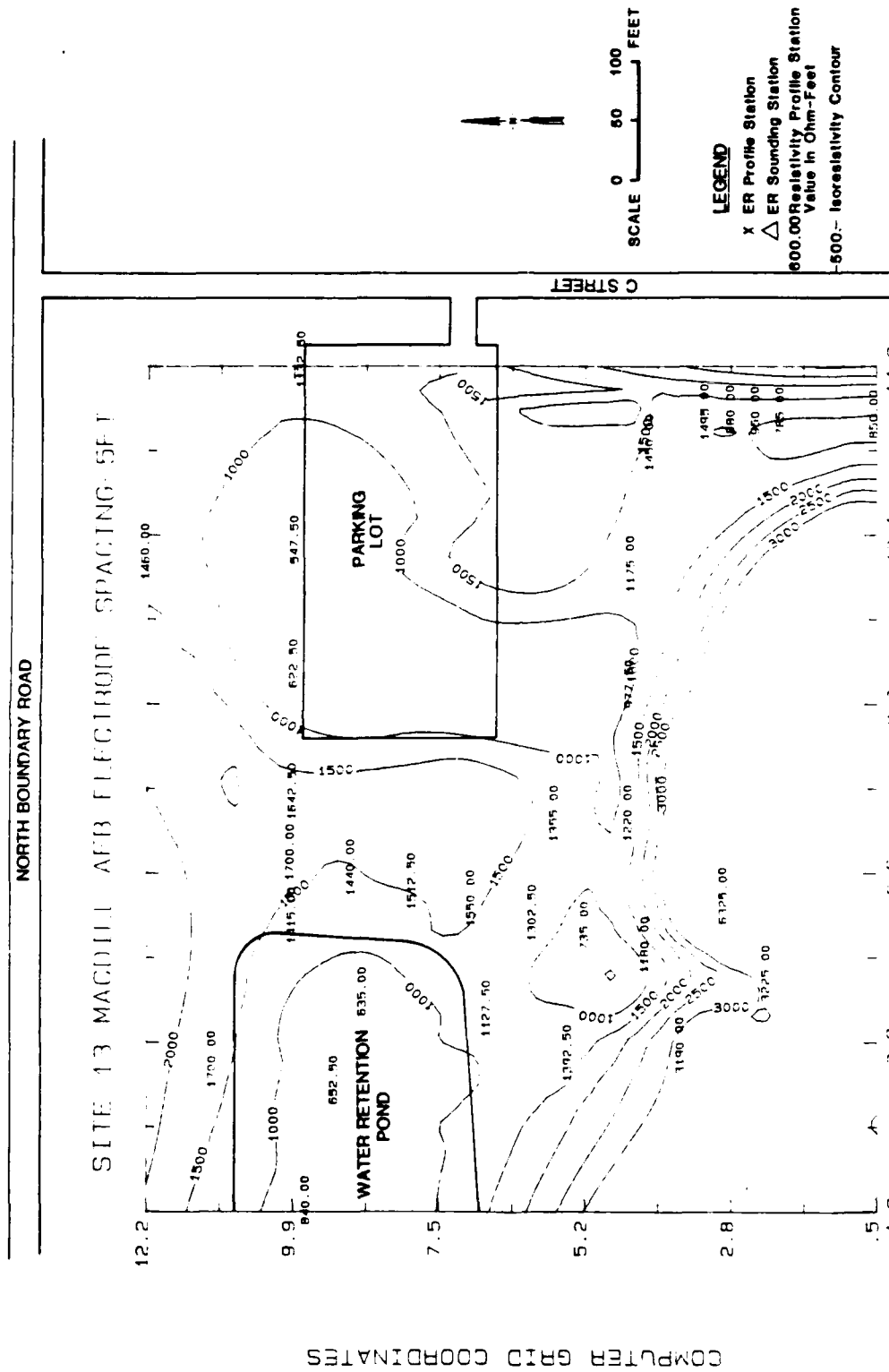
p-p1 spacing (feet)	dial reading (ohms)	scale multiplier	corrected reading (ohms)	k (feet)	apparent resistivity (ohm-ft)	cumulative resistivity (ohm-ft)
2.00	262.00	0.001	0.2620	899.80	233.75	233.75
4.00	464.00	0.001	0.4640	449.50	208.57	444.32
6.00	722.50	0.001	0.7225	299.30	216.24	660.56
8.00	908.00	0.001	0.9080	224.00	203.39	863.95
10.00	100.50	0.010	1.0050	178.80	179.69	1043.63
12.00	151.00	0.010	1.5100	148.50	224.24	1267.88
14.00	154.00	0.010	1.5400	126.80	195.27	1463.15
16.00	161.00	0.010	1.6100	110.50	177.91	1641.06
18.00	218.00	0.010	2.1800	97.80	213.20	1854.26
20.00	249.00	0.010	2.4900	87.50	217.88	2072.14
22.00	281.00	0.010	2.8100	79.10	222.27	2294.41
24.00	294.00	0.010	2.9400	72.00	211.68	2506.09
26.00	329.00	0.010	3.2900	70.00	230.30	2736.39
28.00	345.50	0.010	3.4550	60.80	210.06	2946.45
30.00	385.00	0.010	3.8500	56.30	216.76	3163.21
32.00	402.50	0.010	4.0250	52.30	210.51	3373.71
34.00	473.50	0.010	4.7350	48.70	230.59	3604.31
36.00	489.50	0.010	4.8950	45.50	222.72	3827.03
38.00	527.00	0.010	5.2700	42.60	224.50	4051.53
40.00	545.00	0.010	5.4500	40.00	218.00	4269.53
42.00	584.00	0.010	5.8400	37.60	219.58	4489.12
44.00	658.50	0.010	6.5850	35.40	233.11	4722.23
46.00	696.50	0.010	6.9650	33.40	232.63	4954.86
48.00	738.00	0.010	7.3800	31.50	232.47	5187.33
50.00	733.00	0.010	7.3300	29.80	218.43	5405.76
52.00	922.00	0.010	9.2200	28.10	259.08	5664.84
54.00	113.00	0.100	11.3000	26.60	300.58	5965.42
56.00	119.00	0.100	11.9000	25.10	298.69	6264.11
58.00	123.00	0.100	12.3000	23.80	292.74	6556.85
60.00	135.00	0.100	13.5000	22.50	303.75	6860.60

CORRECTED READING = DIAL READING * SCALE MULTIPLIER = $2\pi IV/I$

$k = 1/[1/(r1) - (1/r2) - (1/r3) + (1/r4)]$

APPARENT RESISTIVITY = $2\pi IV/I * k$

FIGURE F.25



The low resistivity values located within the water retention pond are interpreted to be due to the shallow depth to ground water beneath the pond. Low resistivity values also exist south of the parking lot along C Street. The 10-foot ER profile map (Figure F.26) indicates more prominent low resistivity values southeast of the water retention pond. The 20 and 30-foot ER profile maps (Figure F.27 and F.28, respectively) indicate no anomalously low resistivity areas. The low resistivity values at profile station P-12 at both 20 and 30-foot depths is interpreted to be due to interference from a metal storm sewer pipe which runs parallel to C Street. Not all profile stations were investigated at depths of 20 and 30 feet. The deletions north and south of the site at these depths cause Figure F.27 and Figure F.28 to appear incomplete.

Anomalous resistivity values at Site 13 existed southeast of the water retention pond and along C Street south of the parking lot at depths of 5 and 10 feet. Well MD13-2 was located downgradient of one low resistivity anomaly and well MD3-3 was located downgradient of the other. The location of the creosote pit was unknown and well locations were based upon anomalous patterns in the recorded resistivity values. The upgradient well MD13-1 was located in an area of higher background resistivity. The upgradient and downgradient directions were determined from water level measurements from existing wells completed within the shallow surface aquifer located on MacDill AFB and from the previous investigation conducted by Water and Air Resources, Inc. (Water and Air Resources, 1984).

F.2.5 Site No. 23 (Fire Training Areas)

Resistivity Survey in Active Fire Training Area

The resistivity survey at the Active Fire Training Area consisted of both soundings and profiles. Figure F.29 shows the locations of the sounding and profile stations. The sounding at the Active Fire Training Area was conducted to a depth of 100 feet. Figure F.30 is the graph of the sounding and geologic interpretation based upon the log of well MD23-7 and surrounding deep wells MD23-D1 AND MD23-D2. The sounding did not distinguish the subsurface stratigraphy. A possible solution cavity or fracture, however, was detected at approximately 42 to 45 feet below ground surface within what is interpreted to be the Tampa Limestone. Table F.5 summarizes the sounding data.

FIGURE F.26

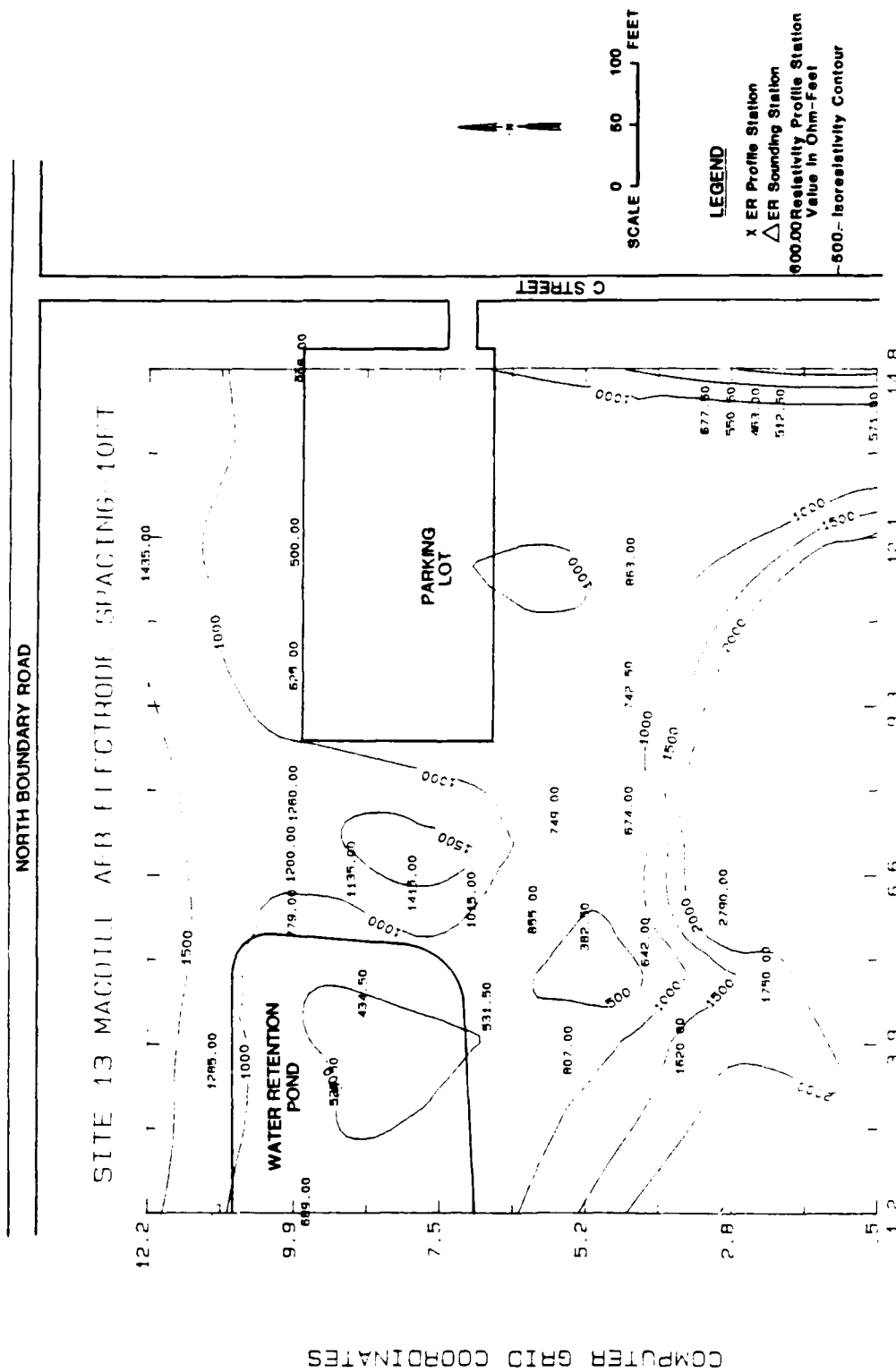


FIGURE F.27

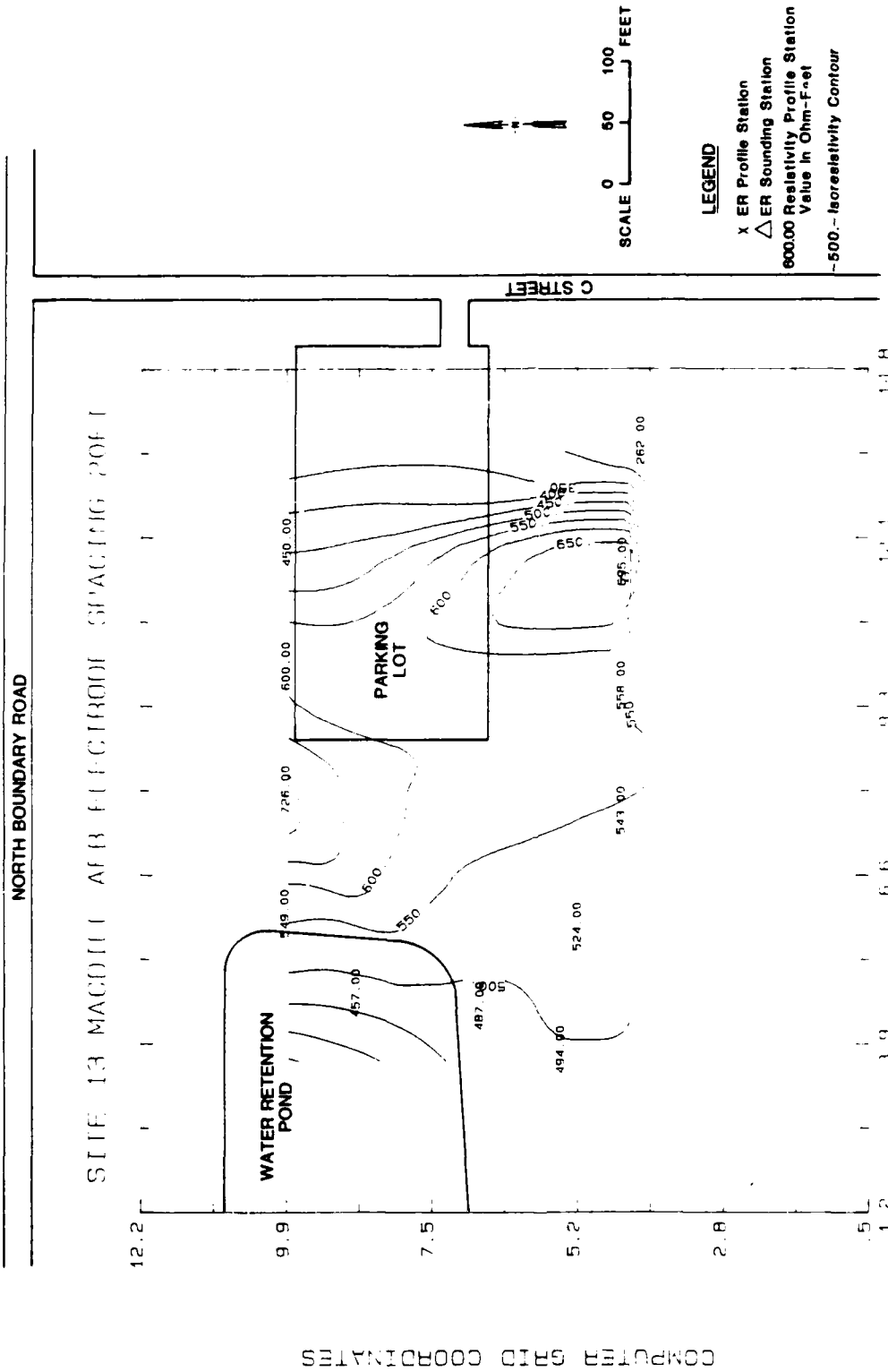


FIGURE F.28

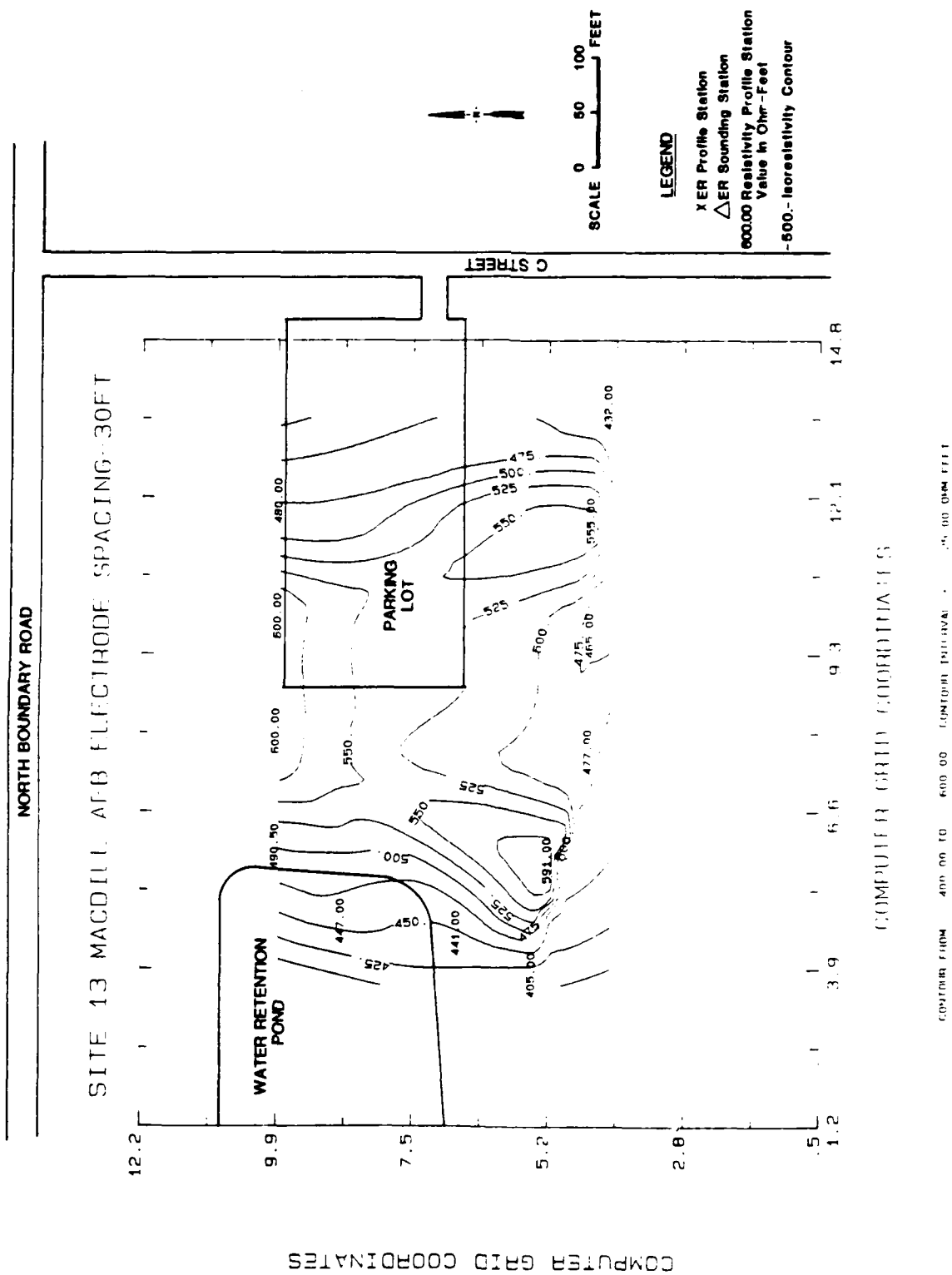


FIGURE F.29

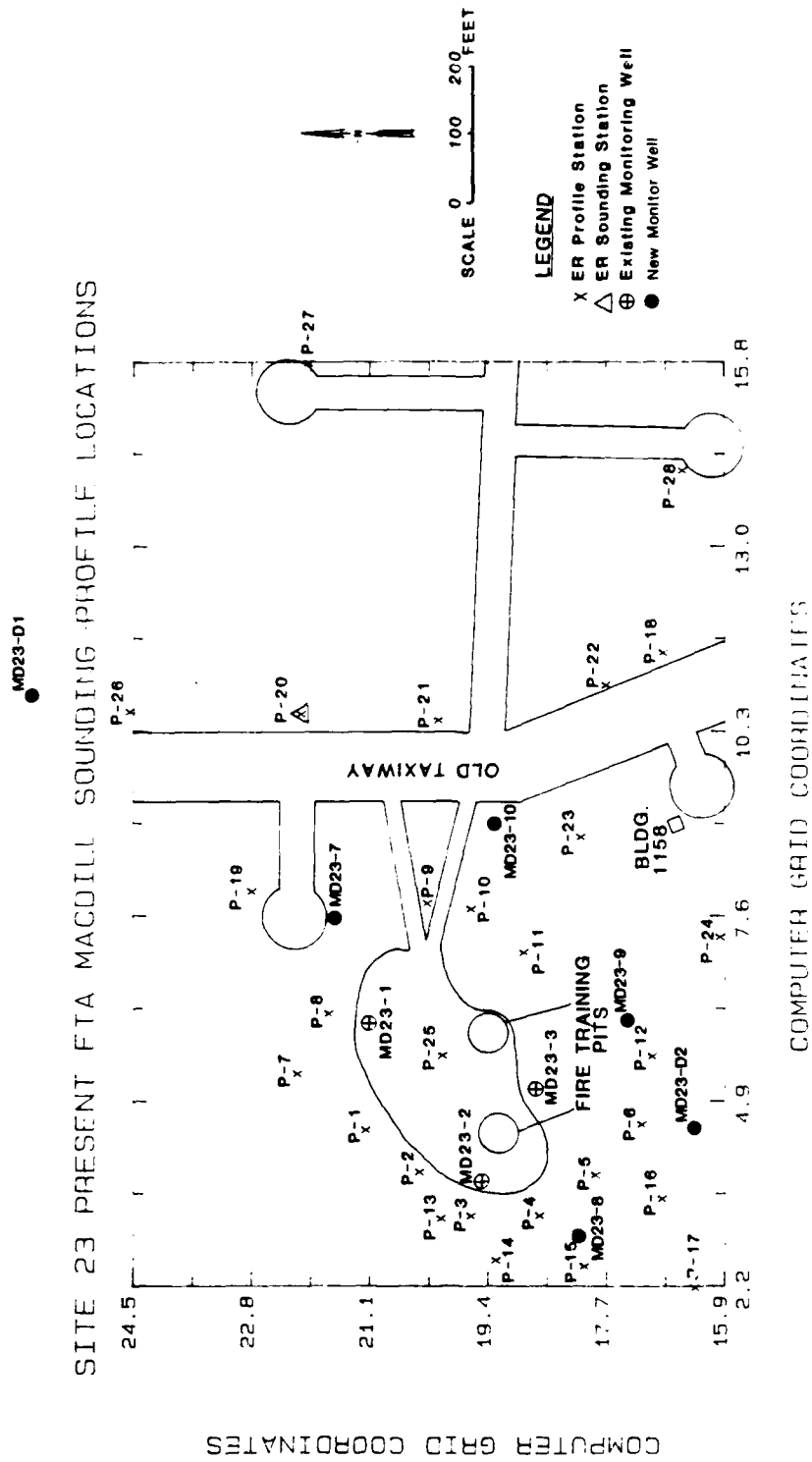


FIGURE F.30

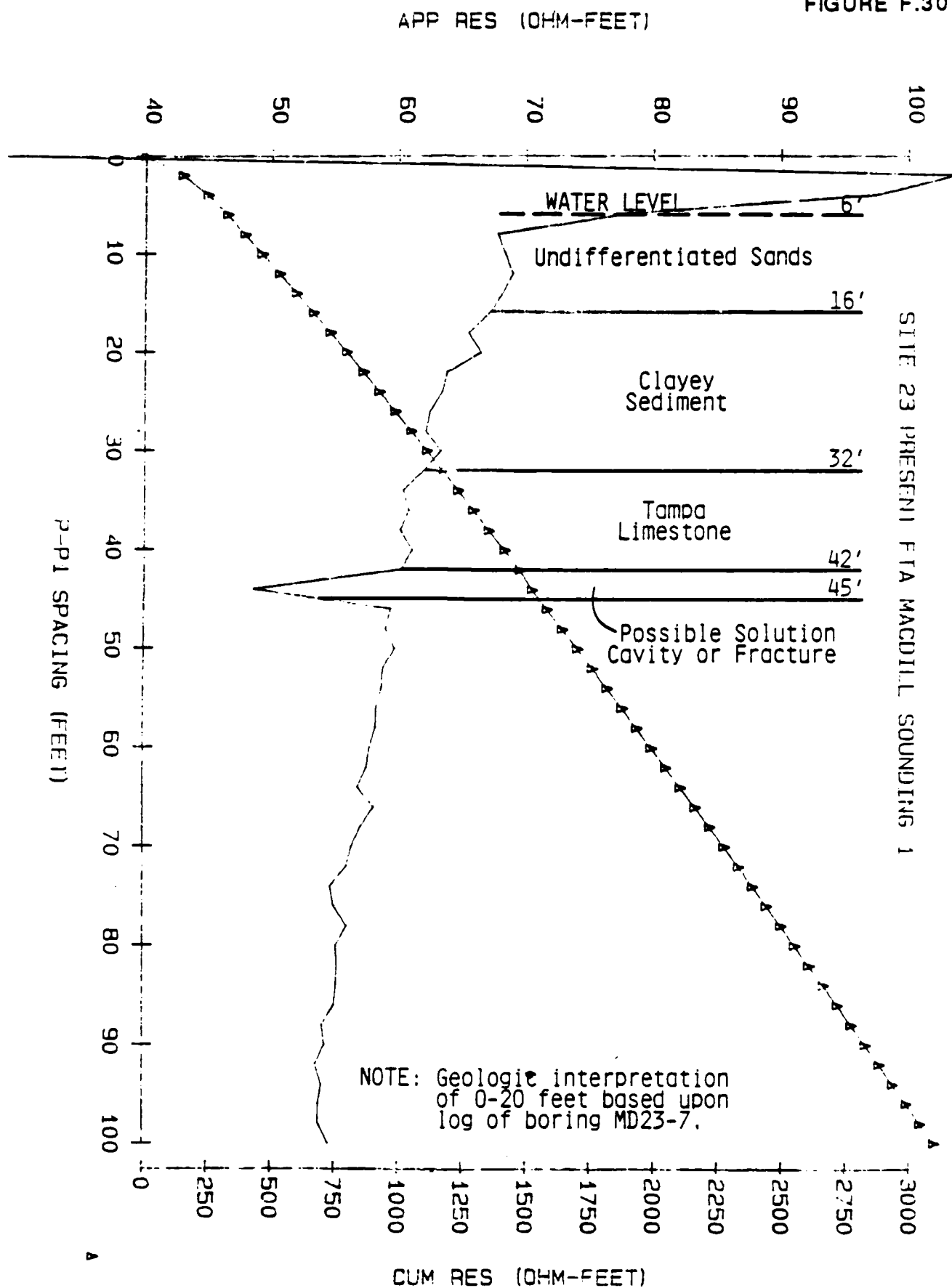


TABLE F.5
SITE 23 PRESENT FTA SOUNDING 1
MACDILL AFB

p-pi spacing (feet)	dial reading (ohms)	scale multiplier	corrected reading (ohms)	k (feet)	apparent resistivity (ohm-ft)	cumulative resistivity (ohm-ft)
2.0	60.0	0.001	0.0600	2499.80	149.99	149.99
4.0	78.0	0.001	0.0780	1249.50	97.46	247.45
6.0	93.0	0.001	0.0930	832.60	77.43	324.88
8.0	108.5	0.001	0.1085	624.00	67.70	392.58
10.0	137.0	0.001	0.1370	498.80	68.34	460.92
12.0	166.0	0.001	0.1660	415.20	68.92	529.84
14.0	191.5	0.001	0.1915	355.40	68.06	597.90
16.0	216.0	0.001	0.2160	310.50	67.07	664.97
18.0	237.5	0.001	0.2375	275.50	65.43	730.40
20.0	268.5	0.001	0.2685	247.50	66.45	796.86
22.0	284.0	0.001	0.2840	224.50	63.76	860.61
24.0	308.5	0.001	0.3085	205.30	63.34	923.95
26.0	330.0	0.001	0.3300	189.10	62.40	986.35
28.0	354.5	0.001	0.3545	175.10	62.07	1048.42
30.0	388.5	0.001	0.3885	162.90	63.29	1111.71
32.0	406.5	0.001	0.4065	152.30	61.91	1173.62
34.0	422.5	0.001	0.4225	142.80	60.33	1233.95
36.0	452.5	0.001	0.4525	134.40	60.82	1294.77
38.0	474.0	0.001	0.4740	126.80	60.10	1354.87
40.0	509.0	0.001	0.5090	120.00	61.08	1415.95
42.0	528.5	0.001	0.5285	113.80	60.14	1476.10
44.0	449.5	0.001	0.4495	108.10	48.59	1524.69
46.0	577.0	0.001	0.5770	102.90	59.37	1584.06
48.0	600.0	0.001	0.6000	98.20	58.92	1642.98
50.0	636.5	0.001	0.6365	93.80	59.70	1702.68
52.0	655.0	0.001	0.6550	89.70	58.75	1761.44
54.0	684.0	0.001	0.6840	85.80	58.69	1820.13
56.0	708.0	0.001	0.7080	82.30	58.27	1878.39
58.0	737.0	0.001	0.7370	79.00	58.22	1936.62
60.0	762.0	0.001	0.7620	75.80	57.76	1994.38
62.0	789.0	0.001	0.7890	72.90	57.52	2051.89
64.0	810.5	0.001	0.8105	70.10	56.82	2108.71
66.0	861.0	0.001	0.8610	67.50	58.12	2166.83
68.0	878.0	0.001	0.8780	65.00	57.07	2223.90
70.0	898.5	0.001	0.8985	62.70	56.34	2280.23
72.0	926.5	0.001	0.9265	60.40	55.96	2336.19
74.0	938.0	0.001	0.9380	58.30	54.69	2390.88
76.0	977.0	0.001	0.9770	56.30	55.01	2445.89
78.0	103.0	0.010	1.0300	54.40	56.03	2501.92
80.0	105.0	0.010	1.0500	52.50	55.13	2557.04
82.0	109.0	0.010	1.0900	50.70	55.26	2612.31
84.0	112.5	0.010	1.1250	49.00	55.13	2667.43
86.0	116.0	0.010	1.1600	47.40	54.98	2722.41
88.0	118.0	0.010	1.1800	45.80	54.04	2776.46
90.0	122.5	0.010	1.2250	44.30	54.27	2830.73
92.0	125.0	0.010	1.2500	42.80	53.50	2884.23
94.0	130.5	0.010	1.3050	41.40	54.03	2938.25
96.0	134.0	0.010	1.3400	40.10	53.73	2991.99
98.0	138.5	0.010	1.3850	38.80	53.74	3045.72
100.0	145.5	0.010	1.4550	37.50	54.56	3100.29

CORRECTED READING = DIAL READING * SCALE MULTIPLIER = $2\pi V/I$
 $k = 1/[(1/r1)-(1/r2)-(1/r3)+(1/r4)]$
 APPARENT RESISTIVITY = $2\pi V/I * k$

The profile measurements obtained at the Active Fire Training Area consisted of electrode spacings of 5, 10, 20, 30 and 50 feet. The five-foot ER profile map (Figure F.31) reveals three areas of low resistivity values. Low values exist within the fire training area (FTA) and to the southwest of the FTA. The values within these two areas are of the same magnitude. The third area of low resistivity is located to the east of the FTA and is much more prominent than the other two (i.e., the resistivity values are significantly lower). The low values cover a large area off-site and extend to the northeast. The 10-foot ER profile map (Figure F.32) indicates two areas of low resistivity. One area is located southwest of the FTA in the same location as in the five-foot profile map. The other area extends eastward directly from the site and contains very low resistivity values. The 20-foot ER profile map (Figure F.33) also indicates two areas of low resistivity. One prominent area again extends directly from the site and broadens to the east. Another low value area exists south of the Active Fire Training Pit. The low values associated with this area are again, higher than those east of the site. The 30-foot ER map (Figure F.34) indicates the same general pattern as the 20-foot profile map. The prominent anomaly at this depth is, however, reduced in areal extent. The 50-foot ER profile map (Figure F.35) indicates only one low resistivity area exists at this depth. The low values at a depth of 50 feet are located southeast to east of the Active Fire Training Area and are greatly reduced in areal extent in comparison with the profiles at shallower depths.

Low resistivity anomalies at the Active FTA existed south and southwest of the fire training pits at depths of 5, 10, 20 and 30 feet below ground surface. A broad area of low resistivity values also existed east of the FTA at all profile depths. The downgradient direction of groundwater flow within the shallow surface aquifer was determined from water level measurements of the existing wells (MD23-1, MD23-2, and MD23-3). Wells MD23-8 and MD23-9 were located downgradient of the site to investigate the low resistivity values south and southwest of the FTA. Well MD23-10 was located downgradient to investigate the low resistivity values east of the FTA. Well MD23-7 was located upgradient of the site in an area of average resistivity values

FIGURE F.31

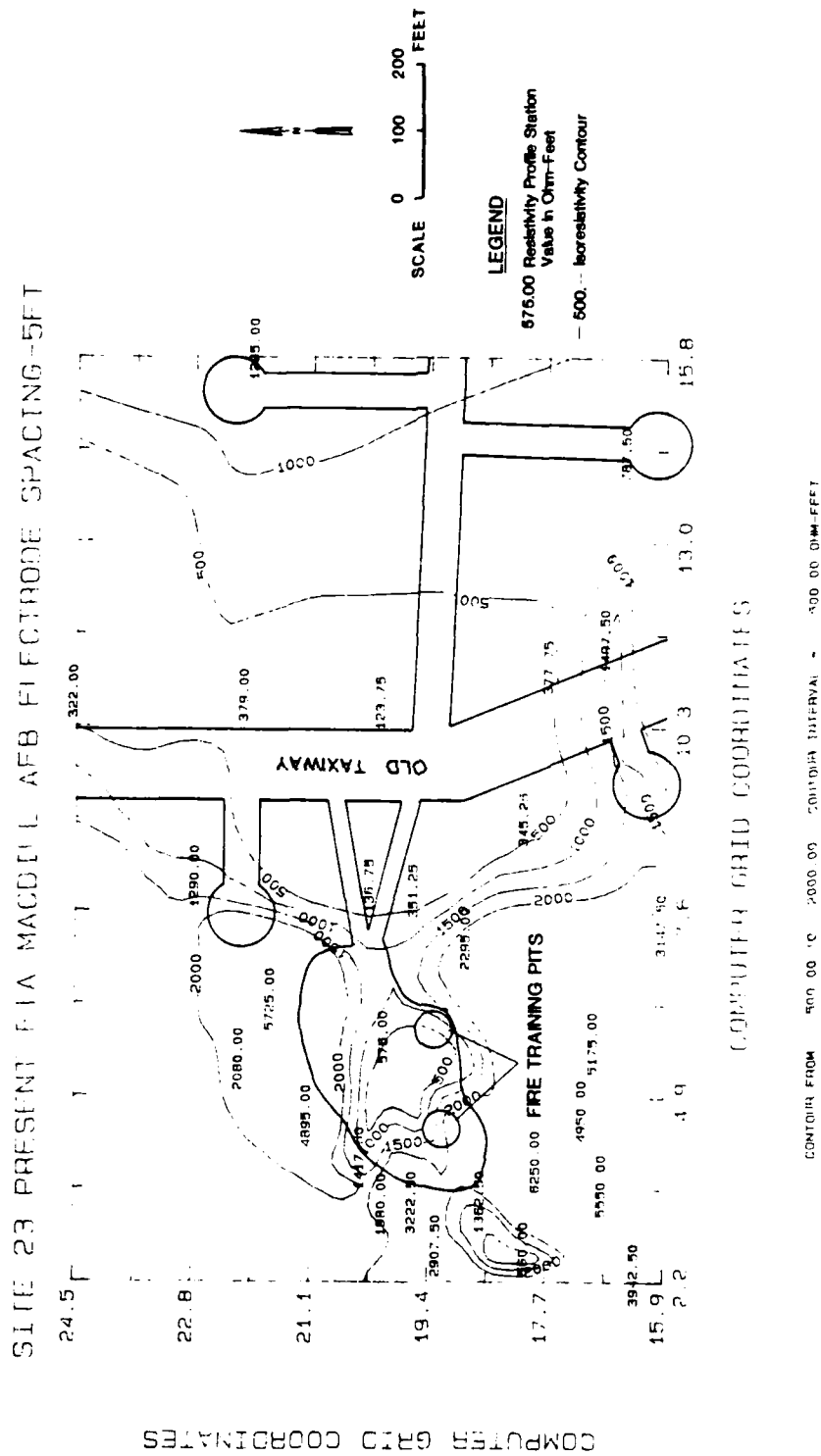


FIGURE F.32

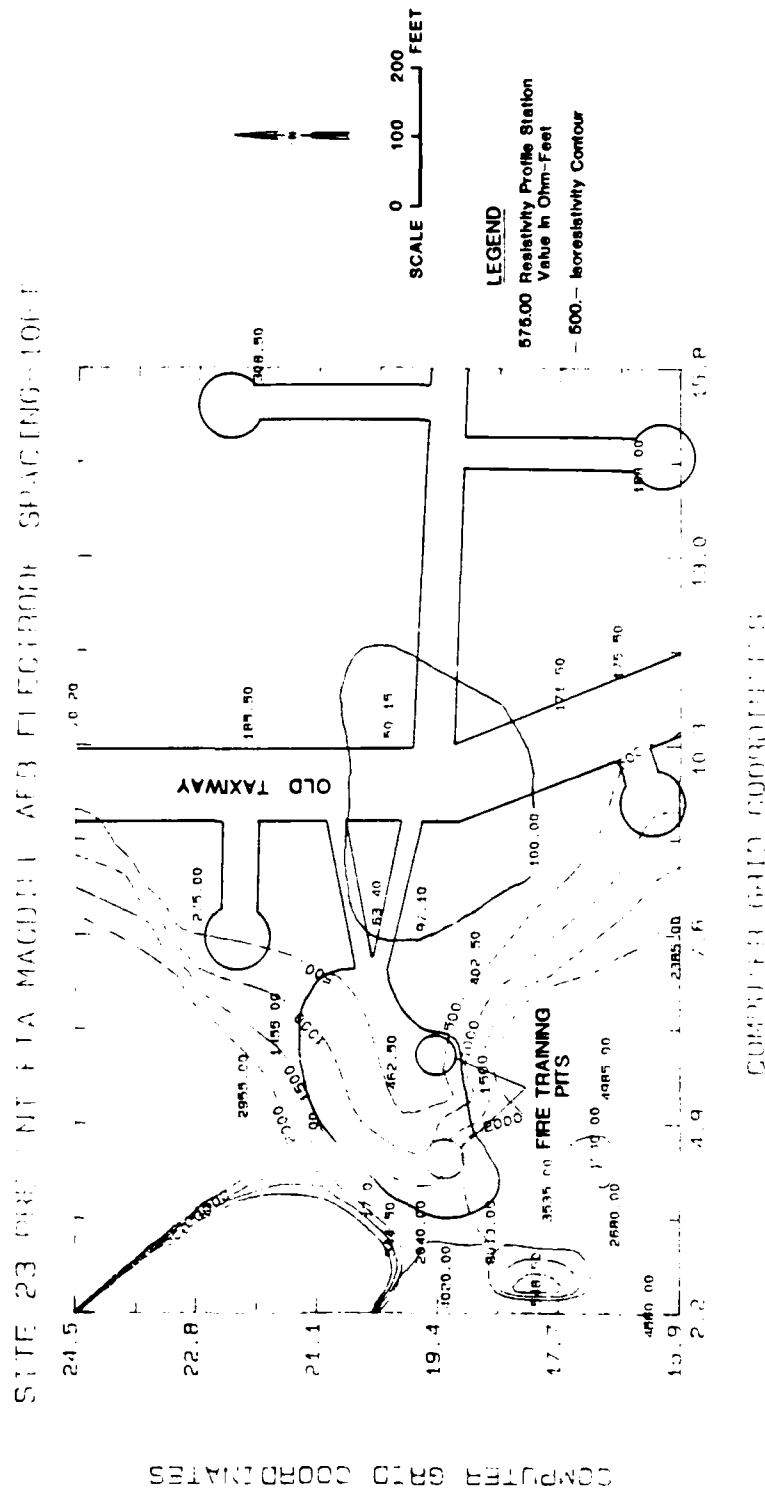


FIGURE F.33

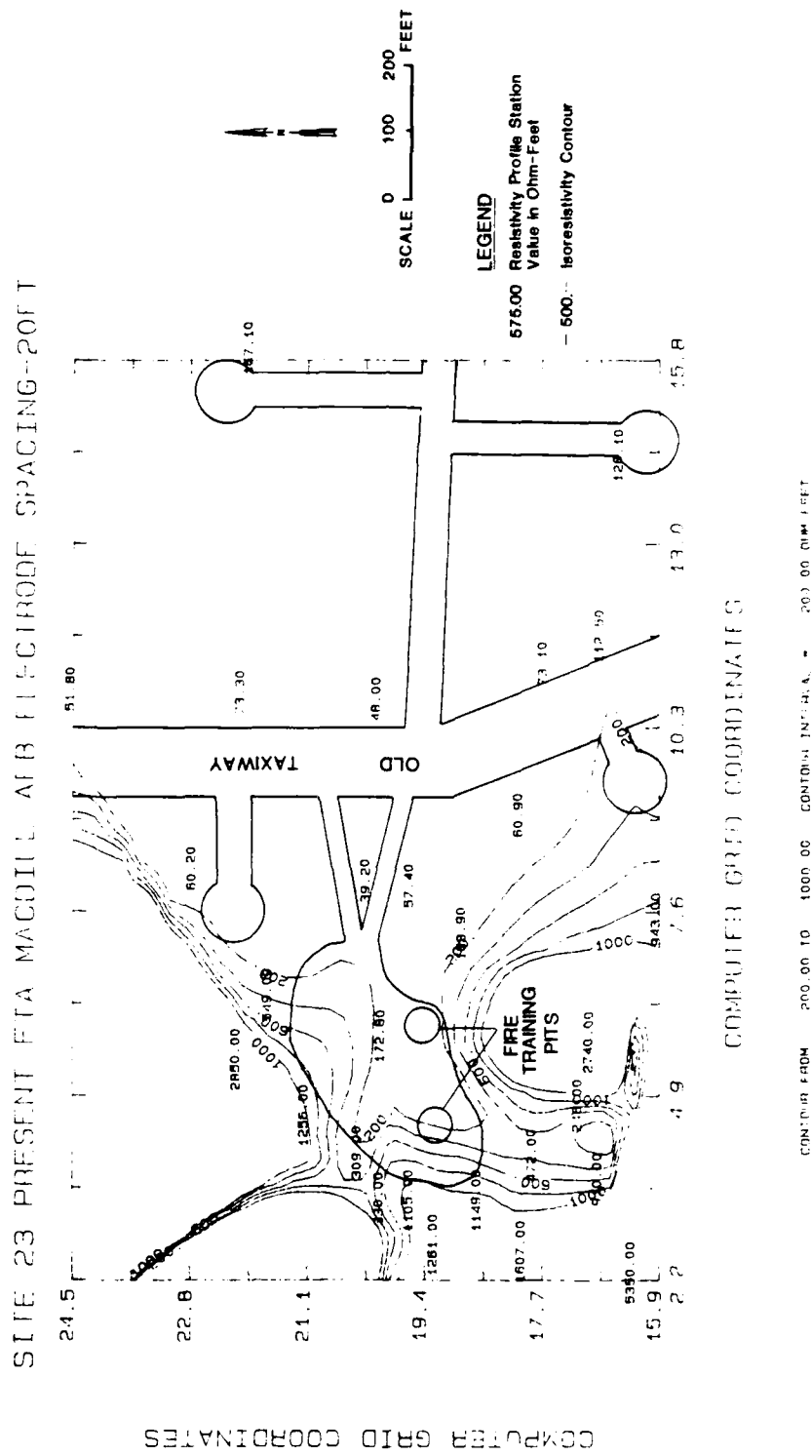


FIGURE F.34

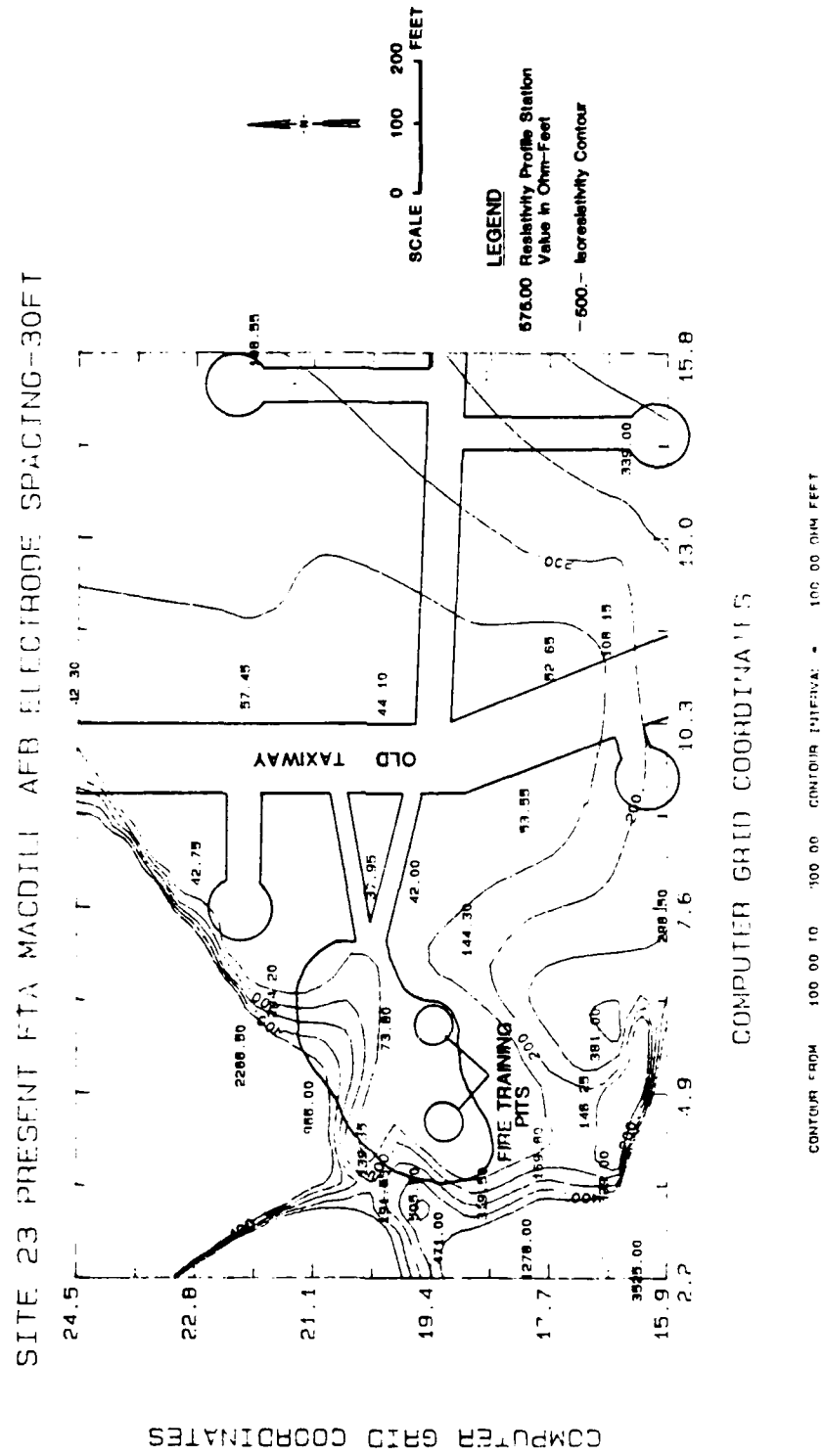
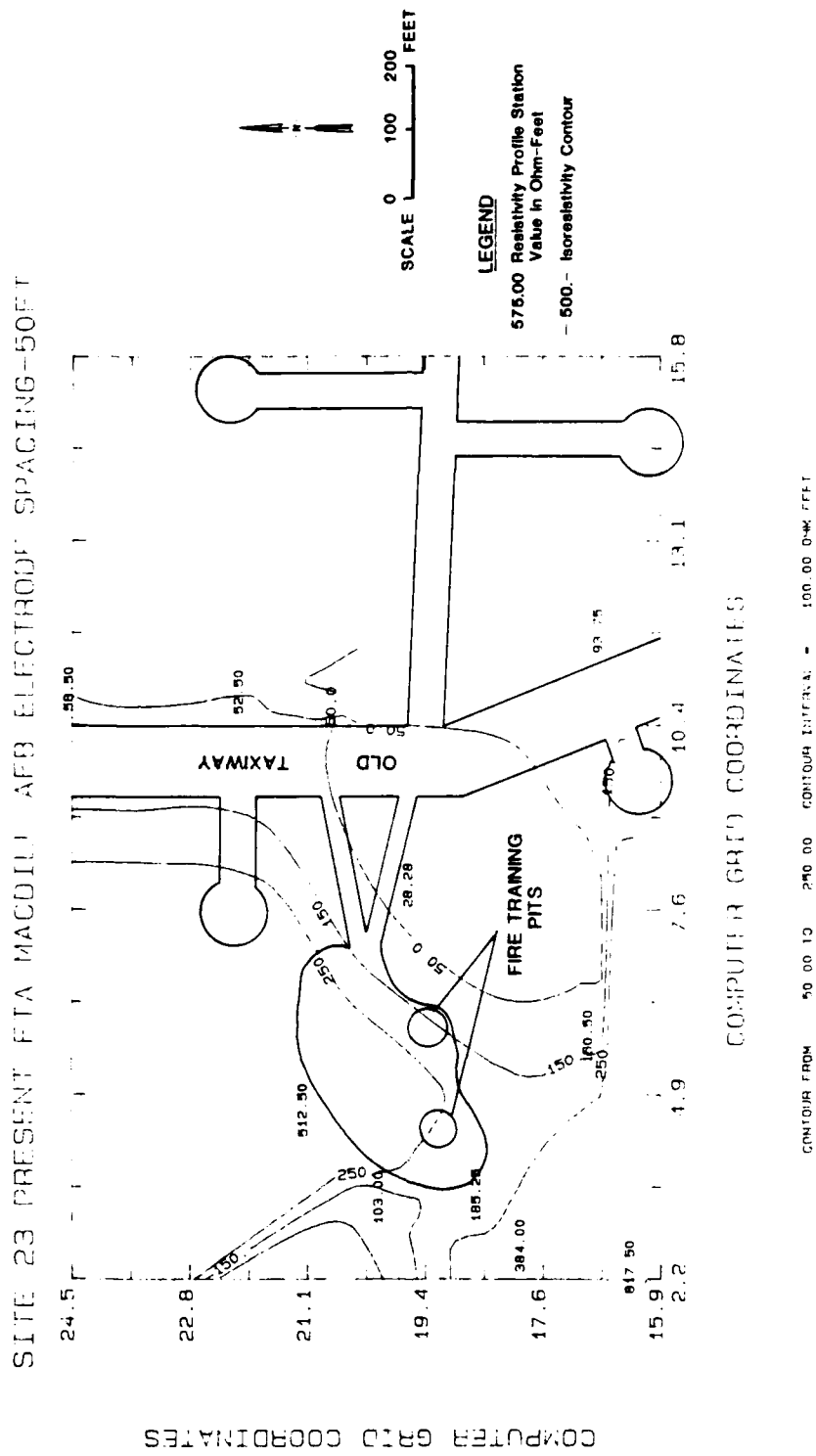


FIGURE F.35



at Site 23. No extensive resistivity anomaly existed at a depth of 50 feet below ground surface. The deep wells installed at the Active FTA, therefore, were located based upon potentiometric maps of the Floridan Aquifer System for the area including MacDill AFB. Deep well MD23-D1 was located upgradient of both the Active and Inactive Fire Training Areas. Well MD23-D2 was located downgradient of the Active FTA. Both wells were completed within the Tampa Limestone of the Floridan Aquifer System.

Resistivity Survey in Inactive Fire Training Area

The resistivity survey at the Inactive Fire Training Area consisted of both soundings and profiles. Figure F.36 shows the locations of the sounding and profile stations. The sounding at the Inactive Fire Training Area was conducted to a depth of 100 feet. Figure F.37 is the graph of the sounding and correlation with logs of existing borings MD23-11, 12, 13 and D3. The sounding was not conclusive in distinguishing subsurface stratigraphy and geologic interpretation is based largely upon subsequent boring log data from wells installed at the site. Table F.6 summarizes the sounding data.

The profile measurements at the Inactive FTA were obtained with electrode spacings of 5, 10, 20, 30 and 50 feet. The five-foot ER profile map (Figure F.38) indicates two areas of low resistivity. A large area of low resistivity values lies south and southeast of the site and extends southeast. A smaller area of low resistivity values exists directly southwest of the inactive fire pit and extends southwest. The 10-foot ER profile map (Figure F.39) indicates two areas of low resistivity in the same locations. The area located southwest of the inactive fire pit at this depth, however, contains values similar to those within the larger area south of the site. The 20-foot ER profile map (Figure F.40) indicates the same pattern of low resistivity values. A connection between the two areas is more evident at this depth than at shallower depths. The 30-foot ER profile map (Figure F.41) indicates one large area of anomalously low resistivity values which extends directly from the Inactive FTA and extends south-southeast away from the site. The 50-foot ER profile map (Figure F.42) indicates the same general pattern of low resistivity values as that of the 30-foot profile depth. The values recorded at this depth, however, are similar over the entire site and are not interpreted as anomalous values.

FIGURE F.36

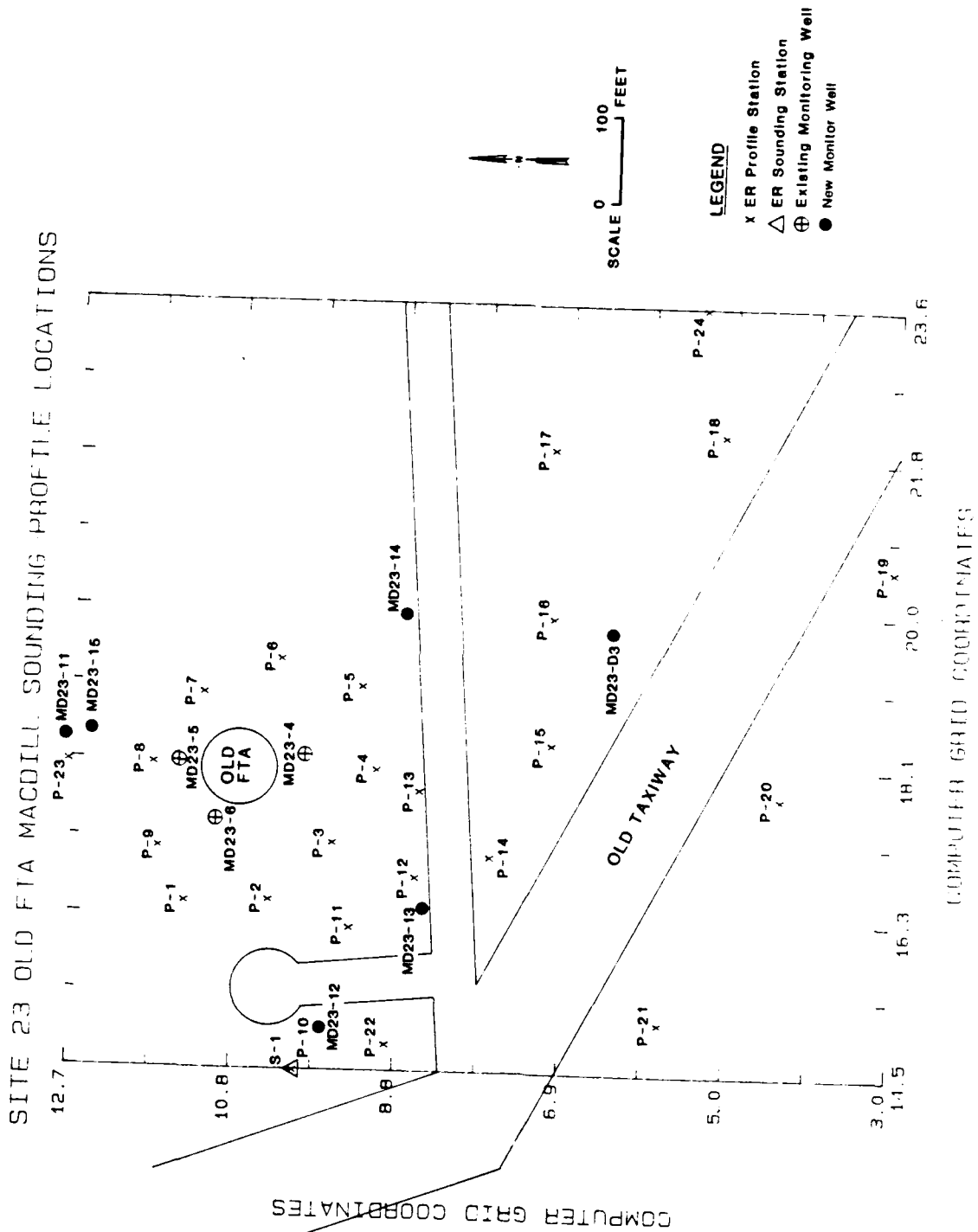


FIGURE F.37

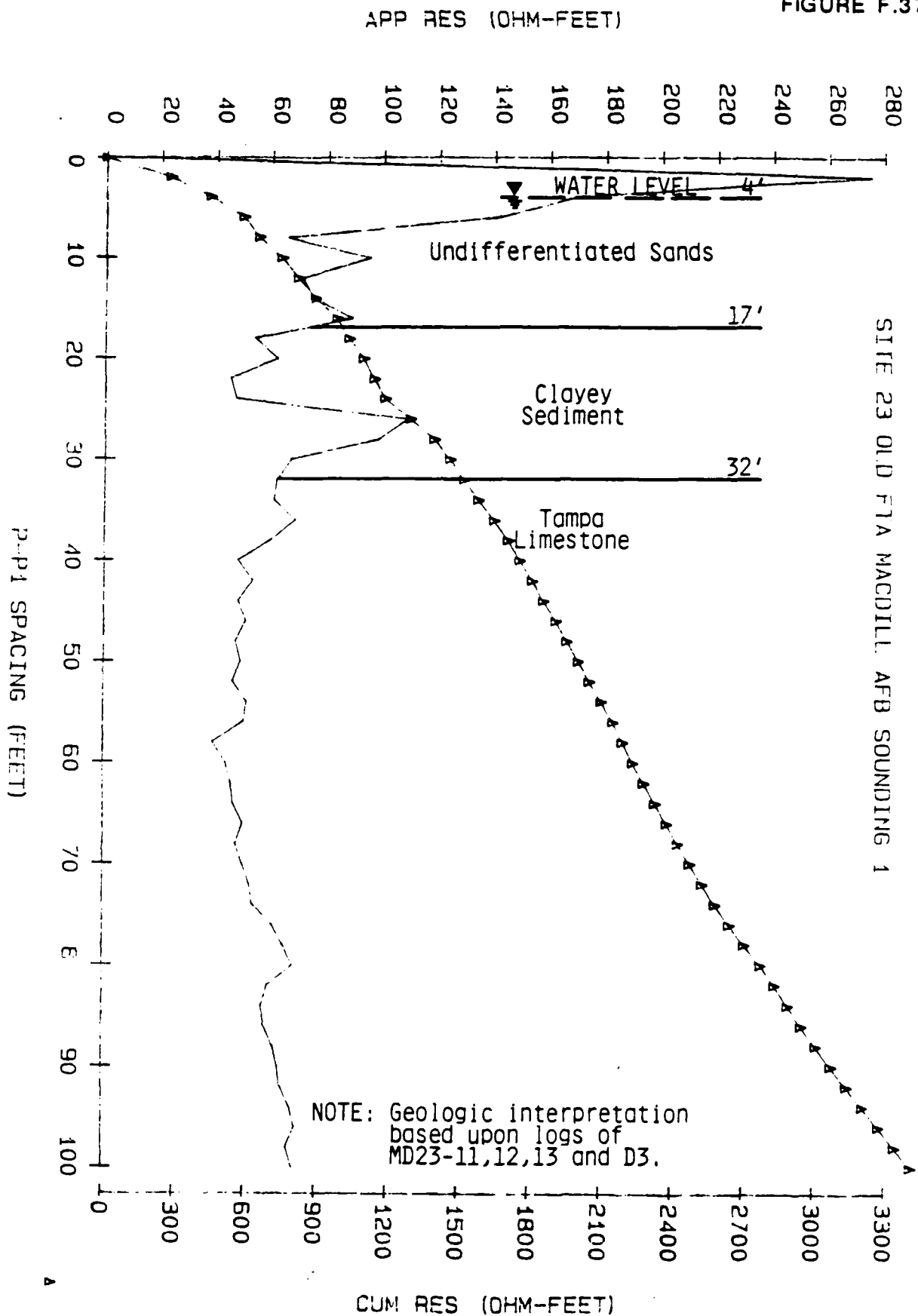


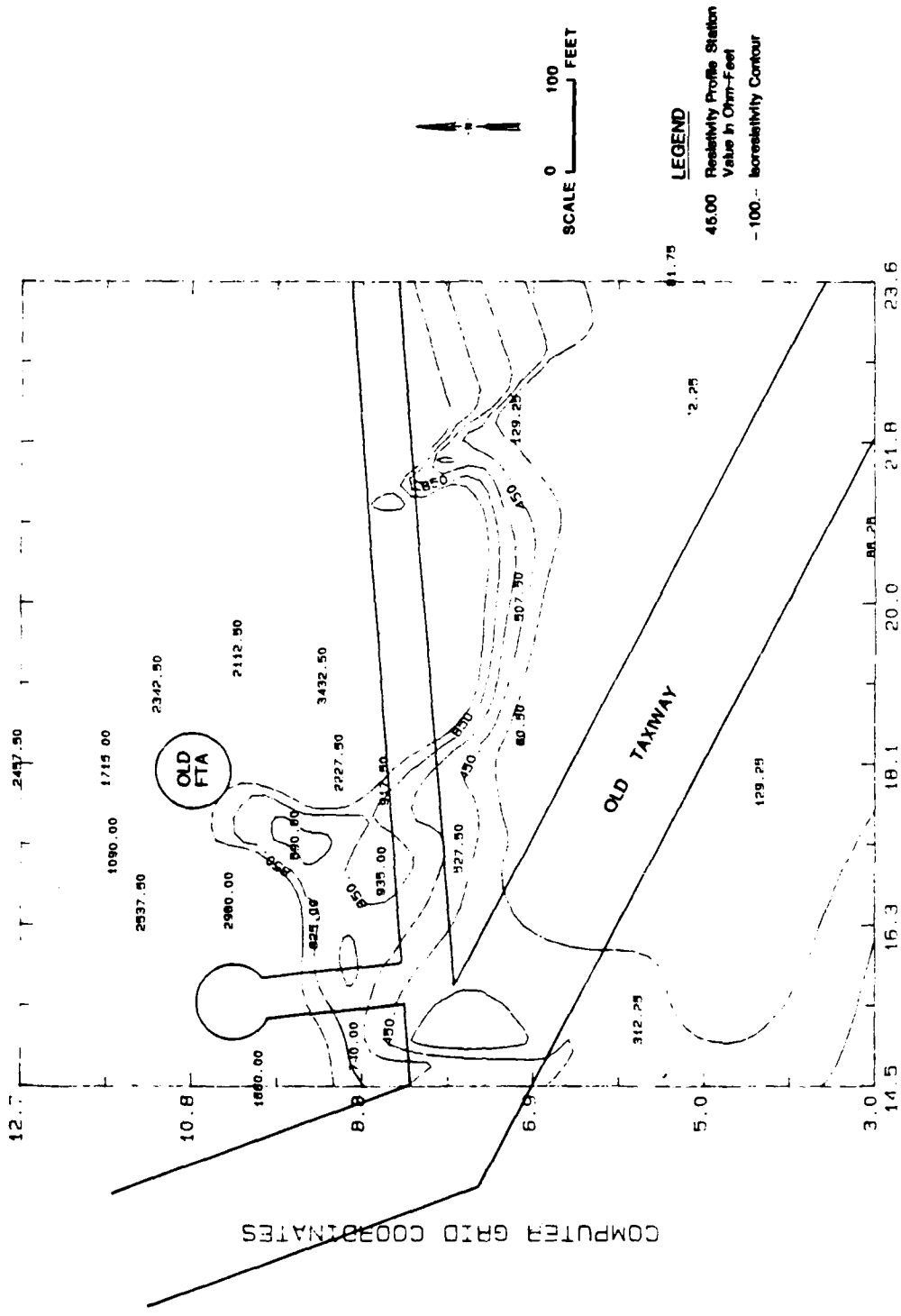
TABLE F.6
SITE 23 OLD FTA SOUNDING 1
MACDILL AFB

p-p1 spacing (feet)	dial reading (ohms)	scale multiplier	corrected reading (ohms)	k (feet)	apparent resistivity (ohm-ft)	cumulative resistivity (ohm-ft)
2.0	11.0	0.010	0.1100	2499.80	274.98	274.98
4.0	13.5	0.010	0.1350	1249.50	168.68	443.66
6.0	17.0	0.010	0.1700	832.60	141.54	585.20
8.0	10.5	0.010	0.1050	624.00	65.52	650.72
10.0	19.0	0.010	0.1900	498.80	94.77	745.49
12.0	17.0	0.010	0.1700	415.20	70.58	816.08
14.0	21.0	0.010	0.2100	355.40	74.63	890.71
16.0	28.5	0.010	0.2850	310.50	88.49	979.21
18.0	19.5	0.010	0.1950	275.50	53.72	1032.93
20.0	25.0	0.010	0.2500	247.50	61.88	1094.80
22.0	20.0	0.010	0.2000	224.50	44.90	1139.70
24.0	23.0	0.010	0.2300	205.30	47.22	1186.92
26.0	57.5	0.010	0.5750	189.10	108.73	1295.65
28.0	56.0	0.010	0.5600	175.10	98.06	1393.71
30.0	41.0	0.010	0.4100	162.90	66.79	1460.50
32.0	40.5	0.010	0.4050	152.30	61.68	1522.18
34.0	42.5	0.010	0.4250	142.80	60.69	1582.87
36.0	51.0	0.010	0.5100	134.40	68.54	1651.41
38.0	47.0	0.010	0.4700	126.80	59.60	1711.01
40.0	40.0	0.010	0.4000	120.00	48.00	1759.01
42.0	47.0	0.010	0.4700	113.80	53.49	1812.50
44.0	44.5	0.010	0.4450	108.10	48.10	1860.60
46.0	49.5	0.010	0.4950	102.90	50.94	1911.54
48.0	48.0	0.010	0.4800	98.20	47.14	1958.67
50.0	52.5	0.010	0.5250	93.80	49.25	2007.92
52.0	51.5	0.010	0.5150	89.70	46.20	2054.11
54.0	60.0	0.010	0.6000	85.80	51.48	2105.59
56.0	61.0	0.010	0.6100	82.30	50.20	2155.80
58.0	49.5	0.010	0.4950	79.00	39.11	2194.90
60.0	58.0	0.010	0.5800	75.80	43.96	2238.87
62.0	63.0	0.010	0.6300	72.90	45.93	2284.79
64.0	66.5	0.010	0.6650	70.10	46.62	2331.41
66.0	74.5	0.010	0.7450	67.50	50.29	2381.70
68.0	73.0	0.010	0.7300	65.00	47.45	2429.15
70.0	80.0	0.010	0.8000	62.70	50.16	2479.31
72.0	87.5	0.010	0.8750	60.40	52.85	2532.16
74.0	92.5	0.010	0.9250	58.30	53.93	2586.08
76.0	108.0	0.010	1.0800	56.30	60.80	2646.89
78.0	119.0	0.010	1.1900	54.40	64.74	2711.62
80.0	130.0	0.010	1.3000	52.50	68.25	2779.87
82.0	116.5	0.010	1.1650	50.70	59.07	2838.94
84.0	116.0	0.010	1.1600	49.00	56.84	2895.78
86.0	122.5	0.010	1.2250	47.40	58.07	2953.84
88.0	134.0	0.010	1.3400	45.80	61.37	3015.22
90.0	142.5	0.010	1.4250	44.30	63.13	3078.34
92.0	149.5	0.010	1.4950	42.80	63.99	3142.33
94.0	163.0	0.010	1.6300	41.40	67.48	3209.81
96.0	173.0	0.010	1.7300	40.10	69.37	3279.18
98.0	170.0	0.010	1.7000	38.80	65.96	3345.14
100.0	182.5	0.010	1.8250	37.50	68.44	3413.58

CORRECTED READING = DIAL READING * SCALE MULTIPLIER = $2\pi V/I$
 $k = 1/[(1/r1)-(1/r2)-(1/r3)+(1/r4)]$
 APPARENT RESISTIVITY = $2\pi V/I * k$

FIGURE F.38

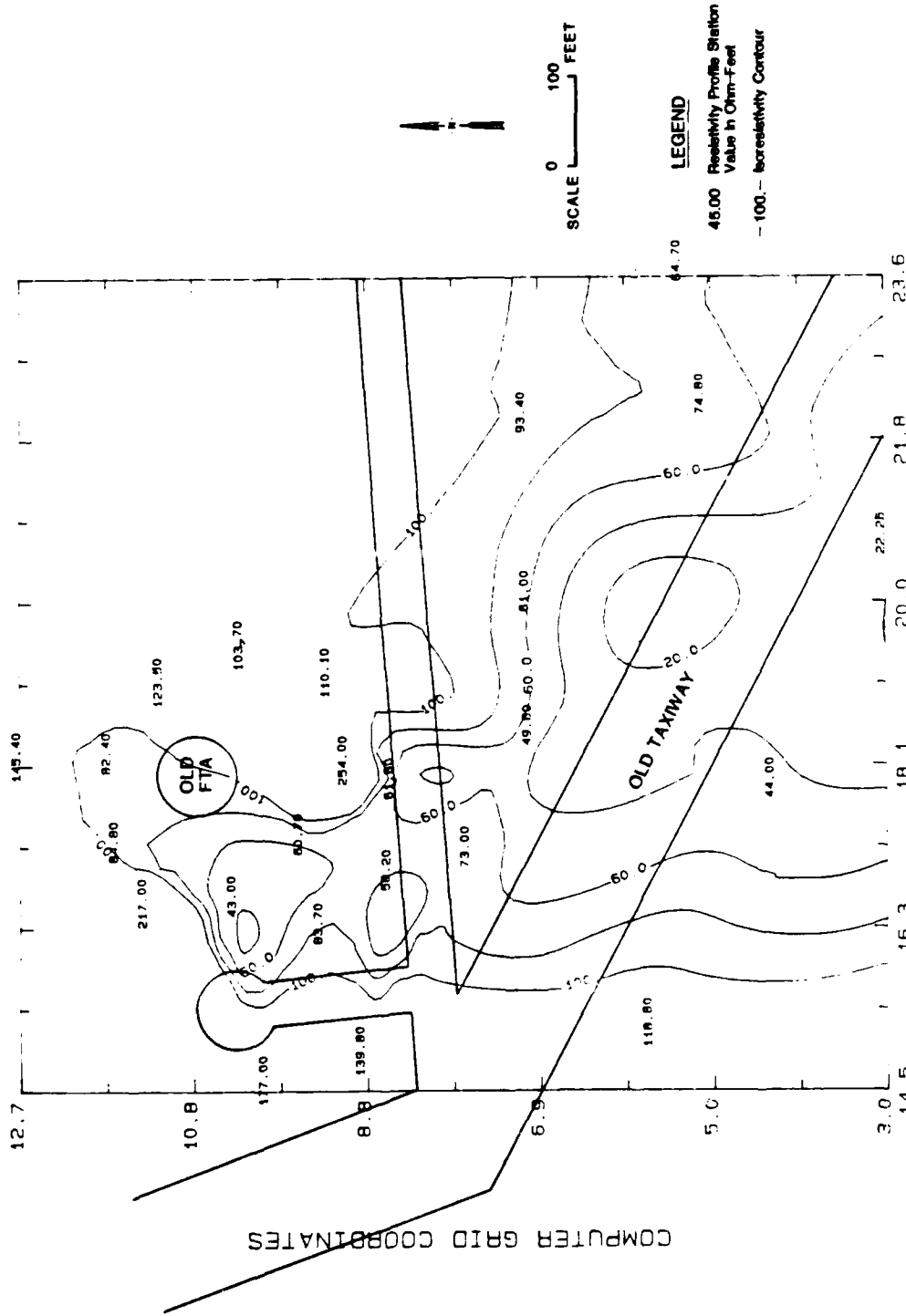
SITE 23 OLD FTA MACDILL AFB ELECTRODE SPACING-5FT



CONTOUR FROM 40.00 TO 100.00 CONTOUR INTERVAL 20.00 OHM FEET

FIGURE F.40

SITE 23 OLD FTA MACDILL AFB ELECTRODE SPACING-20FT



COMPUTER GRID COORDINATES

CONTOUR FROM 20.00 TO 100.00 CONTOUR INTERVAL - 20.00 OHM FEET

FIGURE F.41

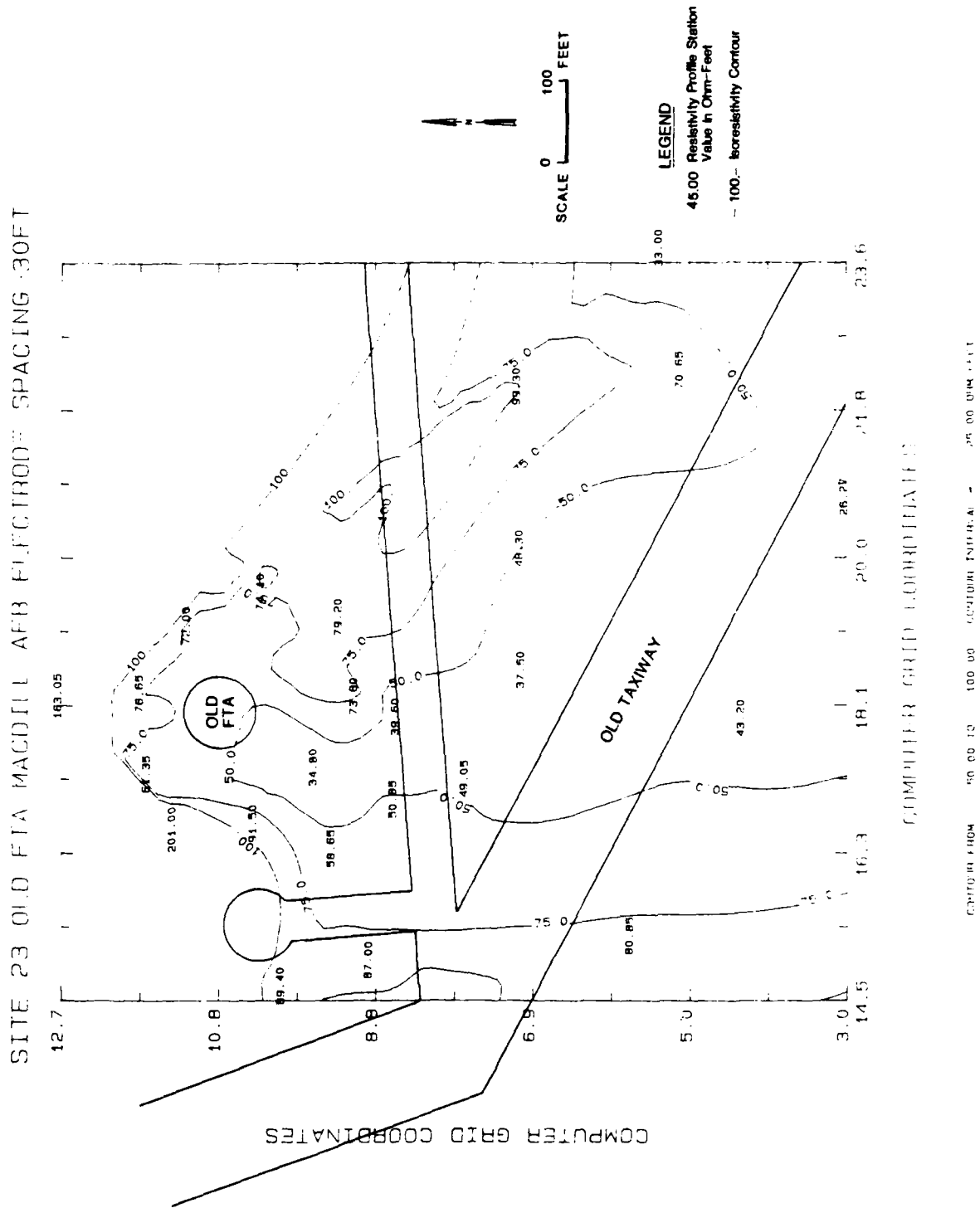
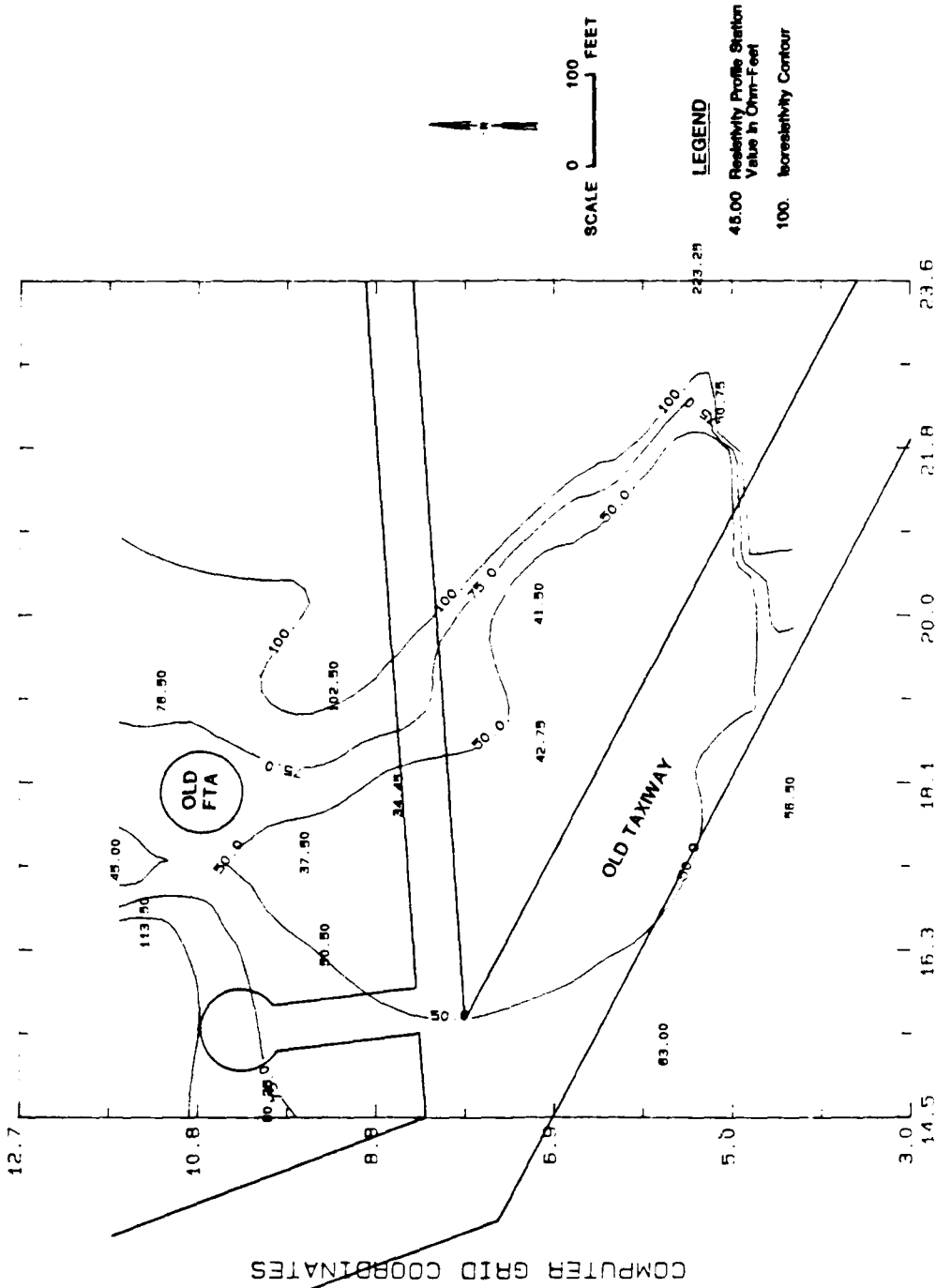


FIGURE F.42

SITE 23 OLD FTA MACDILL AFB ELECTRODE SPACING--50FT



COMPUTER GRID COORDINATES

COORDINATES SHOWN *10.00 TO 100.00 CONTINUOUS INTERVAL - 20.00 DIM. FEET

Low resistivity anomalies at the Inactive FTA existed southwest and south of the site at depths of 5, 10, 20, and 30 feet below ground surface. The downgradient direction of groundwater flow was determined from water level measurements of the existing wells (MD23-4, MD23-5, and MD23-6) and coincided with the direction of low resistivity values from the site. Wells MD23-12 and MD23-13 were located within areas of low resistivity downgradient of the site. Well MD23-14 was located downgradient of the site in an area of high resistivity values. Well MD23-11 was located upgradient of the site in an area of higher background resistivity values. The deep well MD23-D3 was completed within the Tampa Limestone of the Floridan Aquifer System and was located downgradient of the site based upon potentiometric maps of the Floridan Aquifer for the area including MacDill AFB.

F.3 SUMMARY

In summary, the geophysical survey field program consisted of electrical resistivity, magnetic, and metal detection surveys. Electrical resistivity soundings conducted at MacDill AFB were generally not conclusive in distinguishing subsurface stratigraphy. The resistivities of the subsurface sediments were similar, making interpretation of the sounding curves difficult or impossible. The results of the soundings, however, may also have been distorted due to the presence of brackish water within the subsurface units at MacDill AFB. High conductivity brackish water might cause the apparent resistivities of subsurface units to appear similar. Resistivity profile data was also distorted at several sites (Site No. 3 and Site No. 9 specifically) by the presence of brackish water within the subsurface sediments. Brackish areas created low resistivity anomalies and made interpretation of profile data difficult. The following is a site-by-site summary of the significant findings of the program:

F.3.1 Site B

- o The magnetic and metal detection surveys indicated the location of buried fuel storage tanks.

- o The resistivity survey revealed anomalously low resistivity values south and southwest of the southeastern fuel tank cluster at depths of 5 and 10 feet.
- o Well MDB-3 was located downgradient of the site to investigate the anomalous resistivity values. Since no other extensive anomalous patterns were detected at the site, wells MDB-2 and MDB-4 were located in opposite corners downgradient of the site.

F.3.2 Site No. 3

- o The resistivity survey revealed anomalously low resistivity values along the western and southwestern borders of the site and near existing monitor well MD3-3 at depths of 5, 10 and 20 feet.
- o One well (MD3-6) was located upgradient of the site in an area of higher, background resistivity values.

F.3.3 Site No. 9

- o The resistivity survey revealed anomalously low resistivity values to the west and south of the pond as well as along Broad Creek which forms the western boundary of the site. The anomalies were present at depths of 5, 10 and 20 feet.
- o The resistivity survey revealed anomalously high resistivity values existed along the southern portion of the road which leads to the site from Rattlesnake Road at depths of 5 and 10 feet.
- o Downgradient wells MD9-5 and MD9-6 were located south of the landfill in an area of high resistivity values. Downgradient well MD9-7 was located southwest of the pond in an area of low resistivity values. Upgradient well MD9-4 was located north of the site in an area of consistent resistivity values.

F.3.4 Site No. 13

- o The resistivity survey revealed anomalously low resistivity values located approximately 100 feet southeast of the water retention pond and along C Street south of the parking lot at depths of 5 and 10 feet.
- o Two downgradient wells MD13-2 and MD13-3 were located to investigate the anomalous resistivity values. The upgradient well MD13-1 was located in an area of higher, background resistivity values.

F.3.5 Site No. 23

Active Fire Training Area

- o The resistivity survey revealed anomalously low resistivity values to the south and southwest of the FTA and a prominent anomaly extending east from the site. The anomalous values existed at depths of 5, 10, 20, and 30 feet.
- o Wells MD23-8 and MD23-9 were located downgradient of the site to investigate anomalous resistivity values south and southwest of the site. Well MD23-10 was located downgradient of the site to investigate anomalous resistivity values east of the site.
- o No resistivity anomaly existed at a depth of 50 feet, therefore, deep wells MD23-D1 and MD23-D2 were located upgradient and downgradient, respectively, based upon potentiometric maps of the Floridan Aquifer System.

Inactive Fire Training Area

- o The resistivity survey revealed anomalously low resistivity values existed south and southwest of the site at depths of 5, 10, 20, and 30 feet.
- o Wells MD23-12 and MD23-13 were located downgradient of the site to investigate the anomalous resistivity values south and southwest of the site. Well MD23-14 was located downgradient of the site in an area of high resistivity.

- o No resistivity anomaly existed at a depth of 50 feet, therefore, deep well MD23-3 was located downgradient of the site based upon potentiometric maps of the Floridan Aquifer System.

F.4 SITE 11 GEOPHYSICAL SURVEY RESULTS (October 1987)

F.4.1 Site 11 (Chemical Munitions Burial Area)

Electromagnetic Survey

An electromagnetic survey was conducted at Site 11 on October 1, 1987. The survey was performed to identify areas of high conductivity due to metallic debris associated with the burial areas. The site was gridded at 20-foot increments and readings taken every 20 feet across the suspected area. Figure F.43 shows the locations of the electromagnetic stations and Table F.7 shows conductivity values for each station. Figure F.44 shows the results of the electromagnetic survey as a contour plot of the values at each station. The contour plot reveals a zone of high conductivity extending along the southwestern boundary of the site. These high conductivity values are interpreted as saline water intrusion within the mangrove swamp area and not metallic debris. A zone of low conductivity is also present within the site in the southeastern corner. These low conductivity values are associated with raised piles of "dry" sand, not saturated with the saline groundwater of the swampy area.

The electromagnetic survey was not a useful tool for locating the munitions area due to the "masking" effects of the saline groundwater near the surface in the swampy areas of the site.

Magnetic Survey

A magnetic survey was conducted at Site 11 on October 2, 1987. The survey was performed to identify the munitions burial area as an area of high magnetic field intensity associated with buried metallic objects. The magnetic survey was conducted at the same locations as the electromagnetic survey and included areas to the south and west along the roads extending into the swampy area. Figure F.45 shows the locations of the magnetometer stations and Table F.8 shows magnetic field intensity values for each station. Figure F.46 shows the results of the magnetometer survey as a contour plot of the values at each station. The

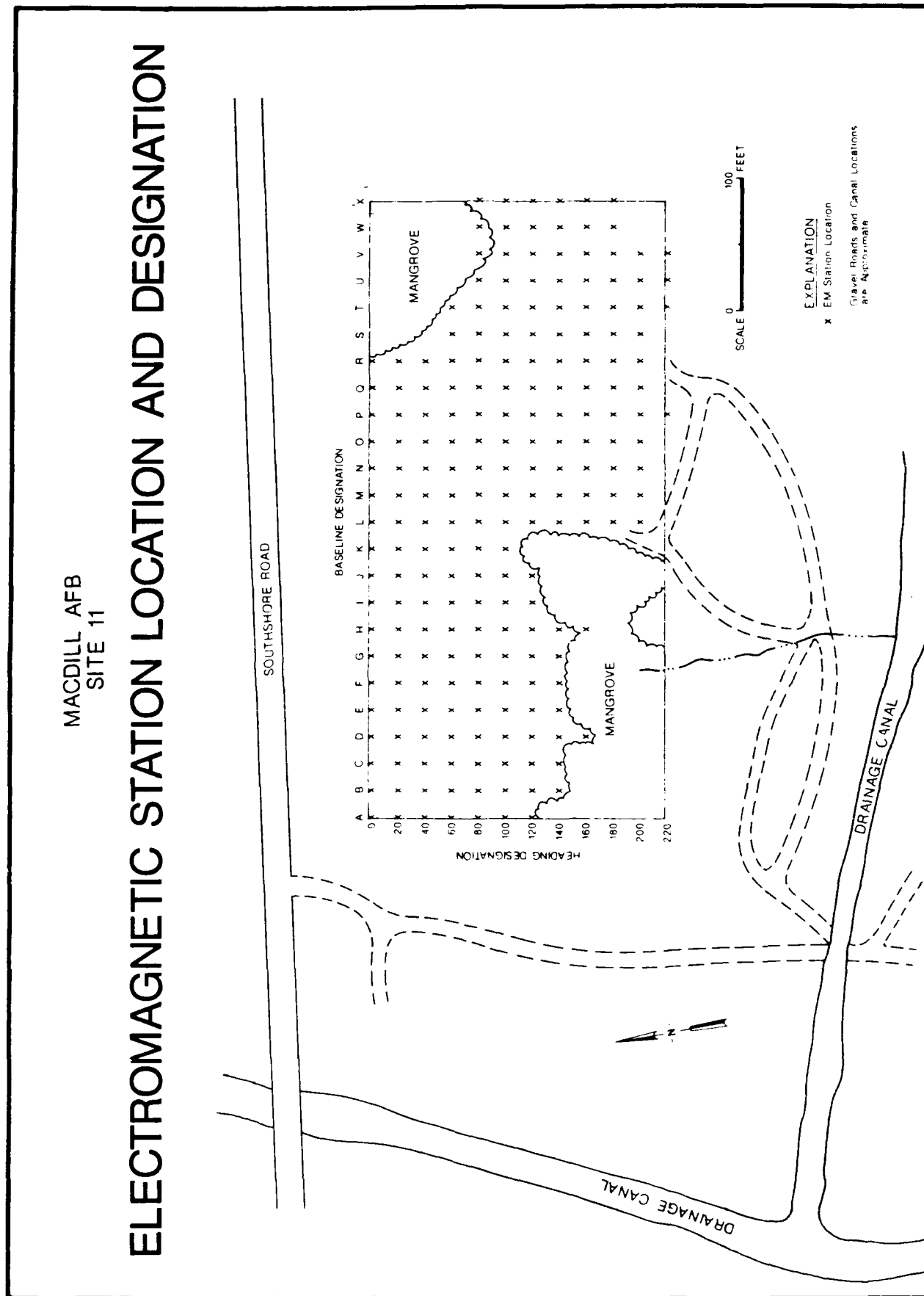


Table F.7

MACDILL AFB
SITE 11
ELECTROMAGNETIC DATA

BASELINE DESIGNATION	HEADING DESIGNATION	SOIL CONDUCTIVITY (MMHOS/METER)
A	0	70
A	20	70
A	40	58
A	60	48
A	80	51
A	100	61
A	120	88
B	0	74
B	20	70
B	40	61
B	60	60
B	80	54
B	100	56
B	120	66
B	140	83
C	0	78
C	20	68
C	40	63
C	60	64
C	80	56
C	100	55
C	120	56
C	140	68
D	0	83
D	20	70
D	40	57
D	60	58
D	80	56
D	100	55
D	120	55
D	140	61
D	160	110
E	0	83
E	20	70
E	40	50
E	60	58
E	80	56
E	100	56
E	120	54
E	140	62
F	0	82
F	20	68
F	40	66
F	60	64

Table F.7

MACDILL AFB
SITE 11
ELECTROMAGNETIC DATA

BASELINE DESIGNATION	HEADING DESIGNATION	SOIL CONDUCTIVITY (MMHOS/METER)
F	80	64
F	100	62
F	120	56
F	140	58
G	0	78
G	20	66
G	40	68
G	60	69
G	80	72
G	100	67
G	120	64
G	140	66
H	0	76
H	20	67
H	40	67
H	60	67
H	80	82
H	100	80
H	120	80
H	140	72
H	160	76
I	0	76
I	20	63
I	40	66
I	60	77
I	80	79
I	100	86
I	120	91
J	0	74
J	20	68
J	40	72
J	60	82
J	80	84
J	100	76
J	120	88
K	0	72
K	20	67
K	40	74
K	60	80
K	80	88
K	100	88
L	0	72
L	20	68
L	40	71

Table F.7

MACDILL AFB
SITE 11
ELECTROMAGNETIC DATA

BASELINE DESIGNATION	HEADING DESIGNATION	SOIL CONDUCTIVITY (MMHOS/METER)
L	60	74
L	80	78
L	100	84
L	120	97
L	140	125
L	160	125
L	180	120
L	200	175
M	0	69
M	20	66
M	40	69
M	60	72
M	80	78
M	100	88
M	120	92
M	140	93
M	160	110
M	180	90
M	200	90
N	0	66
N	20	64
N	40	66
N	60	66
N	80	74
N	100	84
N	120	96
N	140	90
N	160	88
N	180	61
N	200	60
O	0	58
O	20	58
O	40	62
O	60	67
O	80	72
O	100	78
O	120	91
O	140	86
O	160	84
O	180	76
O	200	56
P	0	56
P	20	58
P	40	60

Table F.7

MACDILL AFB
SITE 11
ELECTROMAGNETIC DATA

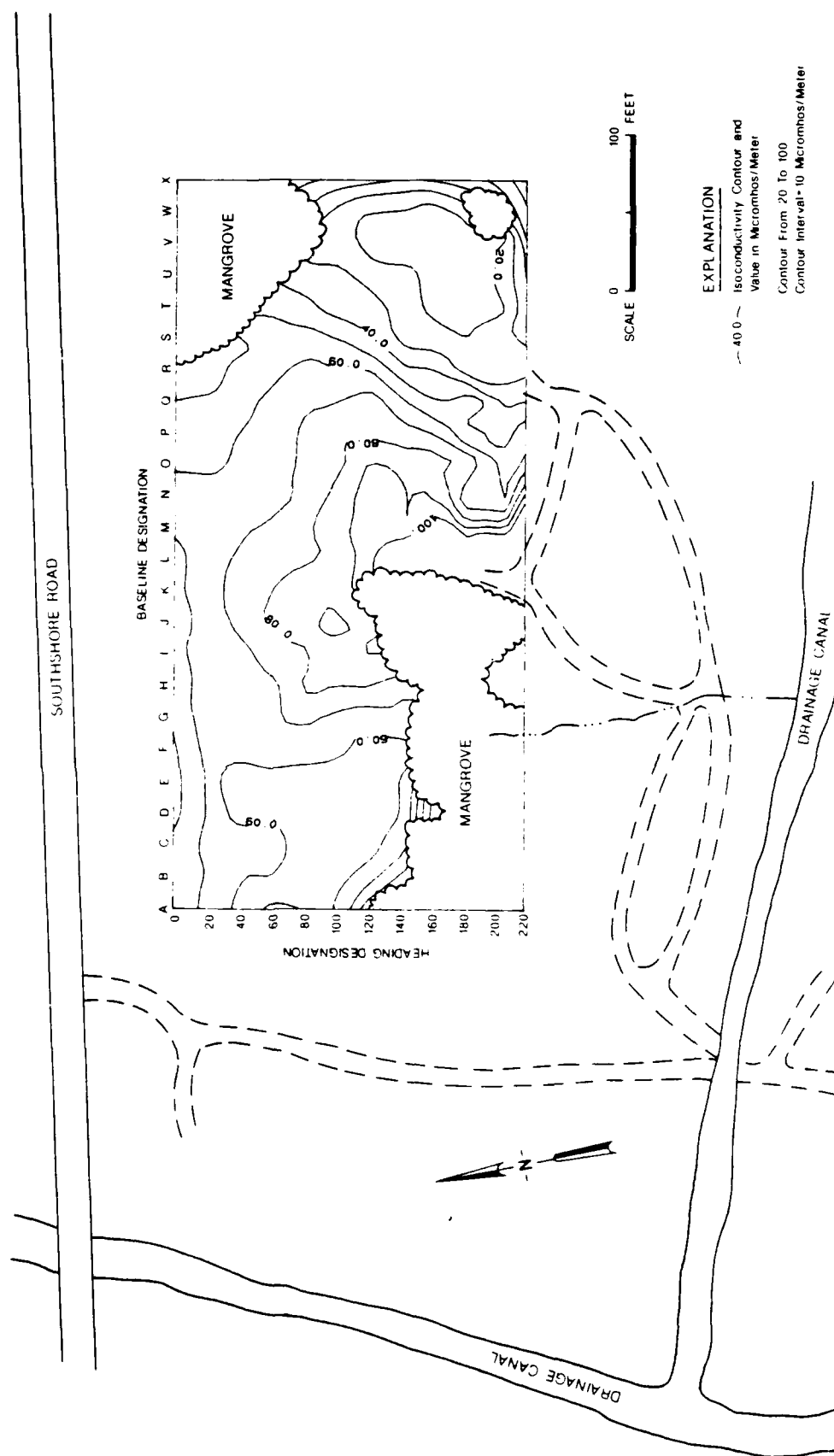
BASELINE DESIGNATION	HEADING DESIGNATION	SOIL CONDUCTIVITY (MMHOS/METER)
P	60	65
P	80	72
P	100	78
P	120	78
P	140	74
P	160	67
P	180	50
P	200	47
P	220	60
Q	0	50
Q	20	52
Q	40	57
Q	60	63
Q	80	68
Q	100	70
Q	120	74
Q	140	60
Q	160	50
Q	180	56
Q	200	38
R	0	45
R	20	42
R	40	56
R	60	57
R	80	63
R	100	60
R	120	58
R	140	42
R	160	39
R	180	22
R	200	25
S	60	54
S	80	53
S	100	49
S	120	40
S	140	26.5
S	160	23.5
S	180	20.5
S	200	29.5
T	60	47
T	80	42
T	100	34
T	120	34
T	140	23

Table F.7

MACDILL AFB
SITE 11
ELECTROMAGNETIC DATA

BASELINE DESIGNATION	HEADING DESIGNATION	SOIL CONDUCTIVITY (MMHOS/METER)
T	160	18
T	180	17
T	200	20
T	220	46
U	80	34
U	100	32
U	120	23.5
U	140	22
U	160	16.5
U	180	15.5
U	200	25
U	220	52
V	80	24.5
V	100	23.5
V	120	16.5
V	140	16
V	160	16
V	180	16.5
V	200	20
V	220	60
W	80	38
W	100	26
W	120	20
W	140	18
W	160	16
W	180	26.5
X	80	52
X	100	47
X	120	43
X	140	39
X	160	42
X	180	47

MACDILL AFB SITE 11 ELECTROMAGNETIC SURVEY



MACDILL AFB
SITE 11

MAGNETOMETER STATION LOCATION AND DESIGNATION

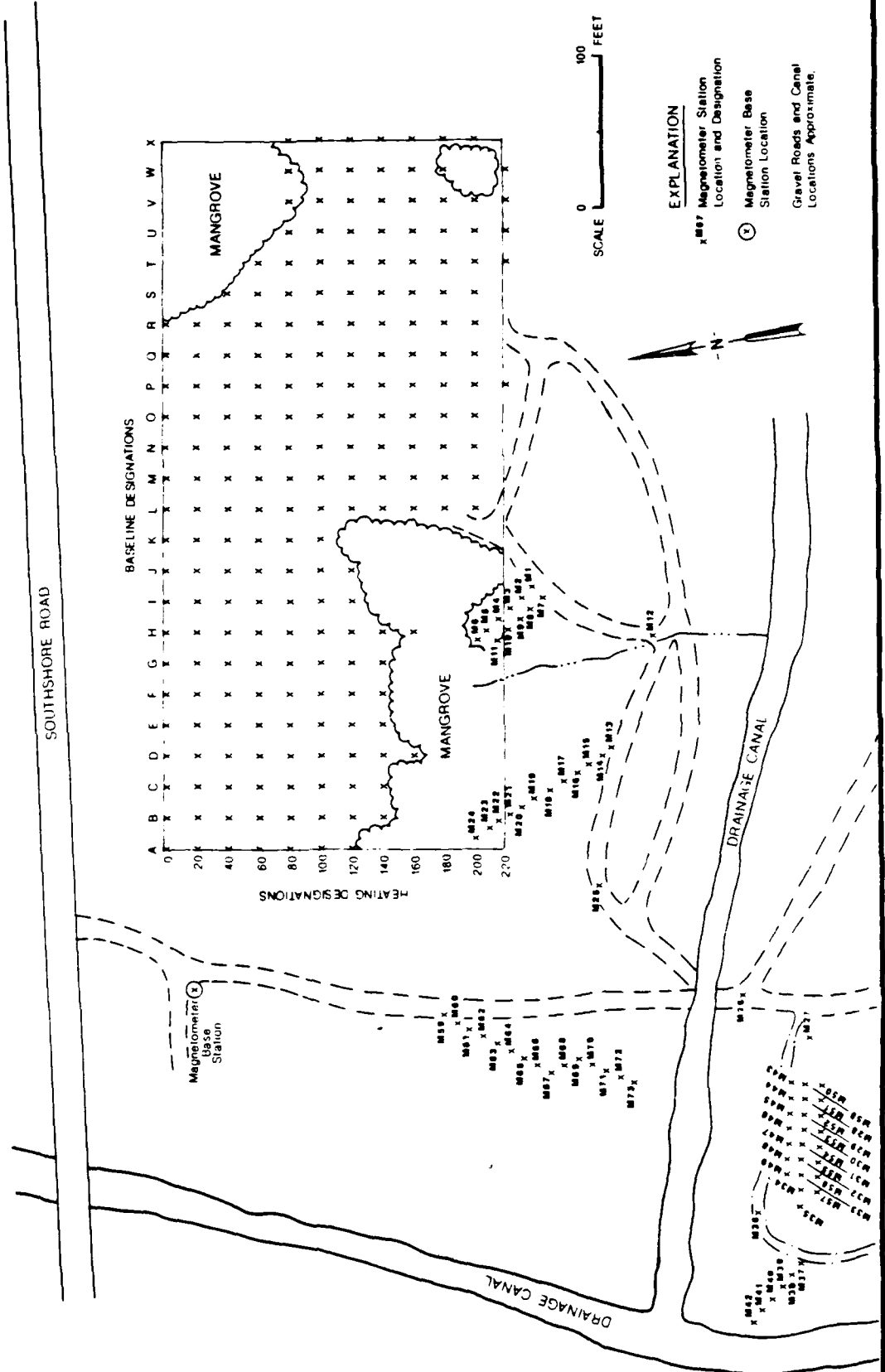


Table F.8

MACDILL AFB
SITE 11
MAGNETOMETER DATA

BASELINE DESIGNATION	HEADING DESIGNATION	MAGNETOMETER VALUE (GAMMAS)
A	0	48950
A	20	48954
A	40	48961
A	60	48961
A	80	48964
A	100	48965
A	120	48968
B	0	48952
B	20	48951
B	40	48963
B	60	48967
B	80	48964
B	100	48964
B	120	48967
B	140	48962
C	0	48955
C	20	48959
C	40	48966
C	60	48967
C	80	48963
C	100	48968
C	120	48969
C	140	48966
D	0	48963
D	20	48965
D	40	48968
D	60	48970
D	80	48970
D	100	48969
D	120	48966
D	140	48971
D	160	48968
E	0	48966
E	20	48968
E	40	48975
E	60	48970
E	80	48970
E	100	48967
E	120	48965
E	140	48967
F	0	48967
F	20	48966
F	40	48977
F	60	48969

Table F.8

MACDILL AFB
SITE 11
MAGNETOMETER DATA

BASELINE DESIGNATION	HEADING DESIGNATION	MAGNETOMETER VALUE (GAMMAS)
F	80	48972
F	100	48972
F	120	48968
F	140	48974
G	0	48973
G	20	48968
G	40	48967
G	60	48971
G	80	48975
G	100	48967
G	120	48971
G	140	48973
H	0	48973
H	20	48973
H	40	48969
H	60	48975
H	80	48973
H	100	48971
H	120	48967
H	140	48965
H	160	48969
I	0	48976
I	20	48969
I	40	48993
I	60	48974
I	80	48970
I	100	48973
I	120	48984
J	0	48974
J	20	48970
J	40	48971
J	60	48972
J	80	48974
J	100	48974
J	120	48971
K	0	48977
K	20	48974
K	40	48977
K	60	48972
K	80	48970
K	100	48972
L	0	48974
L	20	48977
L	40	48976

Table F.8

MACDILL AFB
SITE 11
MAGNETOMETER DATA

BASELINE DESIGNATION	HEADING DESIGNATION	MAGNETOMETER VALUE (GAMMAS)
L	60	48975
L	80	48971
L	100	48971
L	120	48974
L	140	48973
L	160	48969
L	180	48970
L	200	48974
M	0	48973
M	20	48971
M	40	48972
M	60	48977
M	80	48975
M	100	48974
M	120	48970
M	140	48975
M	160	48971
M	180	48973
M	200	48974
N	0	48989
N	20	48980
N	40	48966
N	60	48976
N	80	48975
N	100	48974
N	120	48972
N	140	48972
N	160	48976
N	180	48970
N	200	48972
O	0	48978
O	20	48976
O	40	48974
O	60	48975
O	80	48971
O	100	48973
O	120	48977
O	140	48975
O	160	48977
O	180	48970
O	200	48970
I		48973
I	20	48970
I	40	48970

Table F.8

MACDILL AFB
SITE 11
MAGNETOMETER DATA

BASELINE DESIGNATION	HEADING DESIGNATION	MAGNETOMETER VALUE (GAMMAS)
P	60	48975
P	80	48970
P	100	48967
P	120	48993
P	140	48982
P	160	48978
P	180	48971
P	200	48976
P	220	48977
Q	0	48977
Q	20	48975
Q	40	48971
Q	60	48967
Q	80	48965
Q	100	48888
Q	120	49124
Q	140	48989
Q	160	48977
Q	180	48976
Q	200	48975
R	0	48978
R	20	48972
R	40	48970
R	60	48920
R	80	48970
R	100	48912
R	120	48955
R	140	48979
R	160	48977
R	180	48974
R	200	48971
S	40	48967
S	60	49004
S	80	49020
S	100	48974
S	120	48972
S	140	48972
S	160	48977
S	180	48977
S	200	48979
T	60	48976
T	80	48979
T	100	48977
T	120	48971

Table F.8

MACDILL AFB
SITE 11
MAGNETOMETER DATA

BASELINE DESIGNATION	HEADING DESIGNATION	MAGNETOMETER VALUE (GAMMAS)
T	140	48977
T	160	48979
T	180	48979
T	200	48984
T	220	48975
U	80	48977
U	100	48975
U	120	48977
U	140	48978
U	160	48975
U	180	48979
U	200	48975
U	220	48904
V	80	48970
V	100	48980
V	120	48977
V	140	48973
V	160	48974
V	180	48972
V	200	48976
V	220	48974
W	80	48973
W	100	48977
W	120	48978
W	140	48978
W	160	48981
W	180	48989
W	200	48972
X	80	48978
X	100	48975
X	120	48976
X	140	48971
X	160	48971
X	180	48989
X	200	48980
M1	N/A	48959
M2	N/A	48987
M3	N/A	48990
M4	N/A	48977
M5	N/A	48950
M6	N/A	48951
M7	N/A	48952
M8	N/A	48950
M9	N/A	48952

Table F.8

MACDILL AFB
SITE 11
MAGNETOMETER DATA

BASELINE DESIGNATION	HEADING DESIGNATION	MAGNETOMETER VALUE (GAMMAS)
M10	N/A	48940
M11	N/A	48967
M12	N/A	NR
M13	N/A	48956
M14	N/A	48955
M15	N/A	48955
M16	N/A	48952
M17	N/A	48952
M18	N/A	48955
M19	N/A	48952
M20	N/A	48954
M21	N/A	48955
M22	N/A	48954
M23	N/A	48950
M24	N/A	48949
M25	N/A	NR
M26	N/A	NR
M27	N/A	NR
M28	N/A	48987
M29	N/A	48996
M30	N/A	48964
M31	N/A	48952
M32	N/A	48969
M33	N/A	48975
M34	N/A	48952
M35	N/A	48949
M36	N/A	NR
M37	N/A	48961
M38	N/A	48967
M39	N/A	48972
M40	N/A	48986
M41	N/A	48988
M42	N/A	48955
M43	N/A	48970
M44	N/A	49042
M45	N/A	49066
M46	N/A	48962
M47	N/A	48954
M48	N/A	48959
M49	N/A	48964
M50	N/A	48972
M51	N/A	48975
M52	N/A	48975
M53	N/A	48972

Table F.8

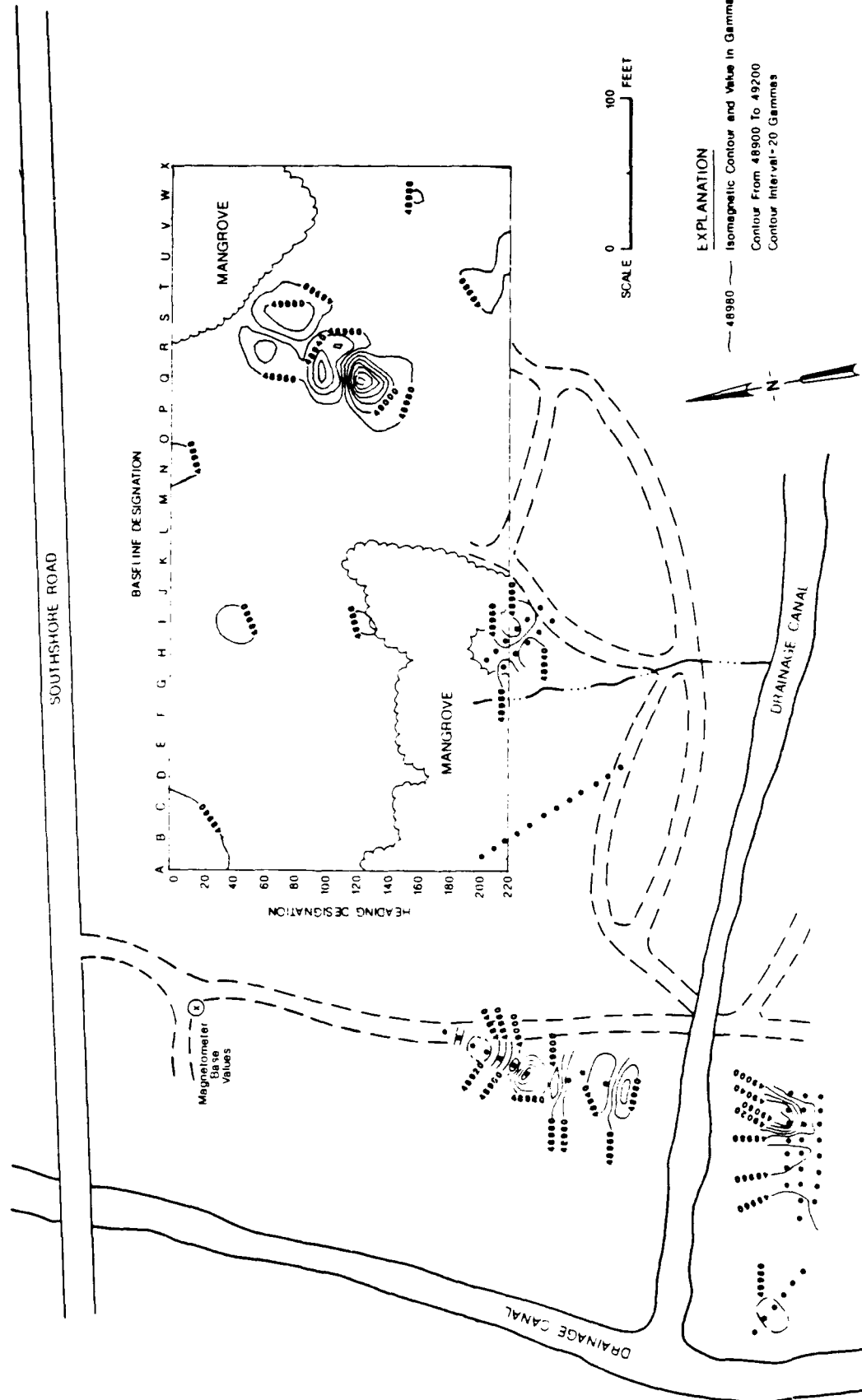
MACDILL AFB
SITE 11
MAGNETOMETER DATA

BASELINE DESIGNATION	HEADING DESIGNATION	MAGNETOMETER VALUE (GAMMAS)
M54	N/A	48969
M55	N/A	48969
M56	N/A	48970
M57	N/A	48968
M58	N/A	48961
M59	N/A	48977
M60	N/A	48957
M61	N/A	48910
M62	N/A	48916
M63	N/A	49055
M64	N/A	49018
M65	N/A	48900
M66	N/A	NR
M67	N/A	49000
M68	N/A	48954
M69	N/A	48954
M70	N/A	48938
M71	N/A	48922
M72	N/A	49004
M73	N/A	48969

FIGURE F.46

MACDILL AFB
SITE 11

MAGNETOMETER SURVEY



contour plot reveals an area of high magnetic intensity in the east-central portion of the gridded area on site. These high values are interpreted as metallic objects buried in this vicinity. The magnetic surveys conducted along the road to the west of the gridded area also show isolated areas of high magnetic field intensity. Surficial and near surface metallic debris were found at these remote sites and magnetometer values may be influenced by their presence.

In summary, the magnetic survey conducted at Site 11 located one large and two smaller high magnetic anomalies. These zones of high magnetic intensity have not been verified to contain buried metallic objects but do show some metallic debris on the surface.

APPENDIX G
STATEMENT OF WORK

INSTALLATION RESTORATION PROGRAM
PHASE II - QUANTIFICATION (STAGE 2)
MACDILL AFB, FLORIDA *

I. DESCRIPTION OF WORK

The overall objective of the Phase II investigation is to define the magnitude, extent, direction and rate of movement of identified contaminants. A series of staged field investigations may be required to meet this objective. The contractor shall recommend any additional investigations required beyond this stage (Stage 2), including an estimate of costs.

The purpose of this task is to undertake a field investigation at MacDill AFB FL (1) to determine the magnitude of contamination and the potential for migration of contaminants in the various environmental media; and (2) to identify potential environmental consequences and health risks of migrating pollutants based on State or Federal standards for those contaminants.

The Phase I and Phase II Stage 1 IRP Reports (mailed under separate cover) incorporated the background, description and previous work for the sites in this task, (except Site B, a new site). To accomplish this survey effort, the contractor shall take the following actions:

A. General

1. Well and Boring Installation

a. All groundwater monitoring wells shall be in accordance with the U.S. EPA Publication 330/9-SI-002, NEIC Manual for Groundwater/Subsurface Investigations at Hazardous Waste Sites for monitoring well installation.

b. All drilling, development, purging, sampling and analytical methods must conform to State requirements. The contractor shall notify the state regulatory personnel as to the start date of field operations (drilling and sampling). This notification must be made as far in advance as possible.

c. Wells shall be of sufficient depth to collect samples representative of aquifer quality and to intercept contaminants if they are present. Wells drilled to intercept floating contaminants shall be screened approximately two feet above the groundwater elevation, where possible.

d. Wells shall be installed upgradient and/or downgradient of sites, as addressed in Item IB. If groundwater gradients are not clearly known at any site, sufficient 2 inch piezometers shall be used to determine the gradient, before monitoring wells are emplaced.

e. The contractor shall monitor all drilling operations with an OVA or similar instrument to identify potential generation of hazardous and/or toxic materials. In addition, the contractor shall monitor drill cuttings for discoloration and odor. During drilling operations, if soil cuttings are suspected to be hazardous (based on OVA measurements, odors, or discoloration), the contractor shall place them in new, contractor-supplied containers and test them as specified in IA1g. All investigation-derived hazardous wastes,

including any contaminated well development/purging water, shall be containerized for disposal by MacDill AFB personnel. Results of this monitoring shall be included in the drilling logs.

f. Monitoring wells shall be installed using the following specifications:

(1) All new wells and borings shall be drilled using appropriate techniques. The contractor's on-site geologist shall select the drilling technique based on local geology and shall prepare drilling logs for all wells installed. Hollow-stem auger shall be used where applicable.

(2) Each well shall be constructed of 2-inch diameter Schedule 40 PVC casing except where otherwise specified. Each well shall be provided with a minimum of 10 feet of Schedule 40 mill slot screen the same diameter as the casing. Screens shall be installed to intercept the groundwater surface, with approximately two feet of screen above the water level. Flush-joint threaded fittings shall be used exclusively (no glued fittings). Screens shall be capped at the bottom. The exact length of screen and slot size of screen shall be determined by the contractor's on-site geologist. All shallow wells are anticipated to be approximately 20 feet deep; the deep wells at Site 23 are anticipated to be 50-70 feet deep.

(3) Each well shall be sand packed with 8-12 mesh silica from the bottom of the well to approximately two feet above the top of the screen. A two-foot bentonite seal shall be emplaced above the sand pack. Type I Portland cement grout shall be emplaced from the top of the bentonite to the ground surface. The bentonite seal shall extend the entire thickness of the clay confining layer, any time the confining layer is penetrated.

(4) The well casing shall be cut off to provide a two- to three-foot stick-up, and a solid cap installed on the casing. A steel guard pipe four feet long shall be placed over the exposed casing and seated in the cement. A locking lid with lock shall be installed on the guard pipe. Steel guard posts, three-inch diameter and six feet long, shall be installed at three points around the well head. Casings shall be provided with vent/drain holes. A concrete pad shall be placed around each well and shall be sloped to drain away from the casing.

(5) Each well installed in a traffic area or any other area specified by the MacDill AFB Point of Contact (POC) shall be installed with a flush completion. The PVC casing must be cut off below ground surface, a locking cap with lock provided, and a flat cover installed over the well head. No guard posts shall be installed around flush-completion wells.

(6) Each well shall be developed as soon as practical after completion by airlift, pumping, or bailing until the discharge water is clear and free of sediment to the fullest extent possible.

(7) The drilling rig and tools shall receive thorough initial cleaning and be decontaminated after each borehole. As a minimum, drill bits shall be steam cleaned after each borehole is installed. Drilling shall proceed from the "least" to the "most" contaminated areas, if possible.

g. All cuttings shall be removed and the general area cleaned following the completion of each well and boring. Only those drill cuttings suspected as being a hazardous waste (based on discoloration, odor, or organic vapor detection instrument) shall be properly containerized (according to local civil engineering office requirements) by the contractor for eventual government disposal. The suspected hazardous waste shall be tested by the contractor for EP Toxicity. A maximum of ten EP Toxicity tests shall be performed. The contractor is not responsible for ultimate disposal of the drill cuttings. Disposal will be conducted by base personnel.

h. All wells shall be surveyed after installation is complete. Elevations shall be determined to the nearest 0.01 foot by surveying from the nearest USCGS or USGS benchmark. Horizontal location shall be determined to an accuracy of 1.0 foot. This information shall be recorded on the site maps.

i. Any borehole not completed as a monitoring well shall be abandoned by grouting from bottom to top with cement grout. The contractor shall also evaluate all monitoring wells installed in IRP Phase II Stage 1 at MacDill AFB and recommend the well abandonment technique to be used as each well is abandoned in the future. The abandonment of completed monitoring wells is not a part of this study.

j. The contractor shall install a maximum of 30 wells. Total footage shall not exceed 750 linear feet (including screens).

k. The exact location and number of monitor wells for each site shall be determined in the field by the contractor in consultation with the USAFOEHL and MacDill AFB POC. The approximate locations and recommended number of wells for sites under investigation are given in the site specific sections of the task.

2. Sampling, analysis and data collection shall be conducted as follows:

a. Water levels shall be measured at all monitoring wells as feet below the ground surface or below the top of casing elevation to the nearest 0.01 feet. Report in terms of mean sea level. Measure static water levels in wells prior to sampling at time of well development.

b. Wells shall be purged prior to initial sampling and resampling of any wells. Purging will be complete when three well volumes of water have been displaced or when the pH, temperature, specific conductance, color, and odor of the discharge are noted to stabilize. Conduct purging operations using a submersible pump where possible. Conduct all sampling using a Teflon bailer. Any deviation from these procedures must be reported and explained in the monthly, draft and final reports.

c. Soil samples shall be obtained from hollow-stem drilling operations through the use of split-spoon samplers. Samples shall be collected every five feet for visual classification. Soil samples at Site AP-9 shall be obtained using a trowel or hand auger.

d. Surface water/sediment samples are specified at several sites. One surface water sample and one sediment sample shall be obtained at each sample location specified. Samples shall be obtained so as to not cause cross-contamination; obtain downstream samples first, and obtain the water sample at each location before the sediment sample.

e.. Decontaminate all sampling equipment, including internal components, prior to use and between samples to avoid cross-contamination. Wash equipment with a laboratory-grade detergent followed by drinking quality water, ASTM Type II Reagent Water, pesticide-grade methanol, and pesticide-grade hexane rinses. Allow sufficient time for the solvent to evaporate and the equipment to dry completely before reuse. Sampling equipment used to collect samples for organics analysis shall not be allowed to come in contact with any type of plastic (e.g., plastic storage bags).

f. Insure that the Type II Reagent Water used to ^{de-}contaminate sampling equipment is free of contaminants which may interfere with the required laboratory analyses. Type II reagent water is prepared using a still designed to produce a distillate having a conductivity of less than 1.0 micromho/cm (at 25 deg C). Double distillation and special features (e.g., degassing, activated charcoal filtration) are usually required to achieve the Type II Reagent water specification. Distilled water purchased from local supply stores (e.g., supermarket) is not Type II reagent water. Furnish the analytical data or manufacturer's certification which verifies the quality of the Type II Reagent Water.

g. Locations where surface water or sediment samples are taken, or where soil exploratory borings are drilled shall be marked with a permanent marker, and the location marked on a project map of the site.

h. All water samples collected shall be analyzed on site by the contractor for pH, temperature, and specific conductance. Sampling, maximum holding time, and preservation of samples shall strictly comply with the following references: Standard Methods for the Examination of Water and Wastewater, 15th Ed. (1980), pp. 35-42; ASTM, Section 11, Water and Environmental Technology; Methods for Organic Chemical Analysis of Municipal of Waters and Wastes, EPA Manual 600/4-82-057; and Methods for Chemical Analysis of Waters and Wastes, EPA Manual 600/4-79-020, pp. xiii to xix (1983). All chemical analyses (water and solid) shall meet the required limits of detection for the applicable EPA method identified in Attachment 1. Summarize sampling methods used, detection levels, and holding times in a table included in the Appendix.

i. The contractor shall collect and analyze an additional 10% of all samples, for each parameter, for field quality control purposes, as indicated in Attachment 1. Include internal quality control data (lab blanks, lab spikes, and lab duplicates) in the report, as well as field quality control data. Maintain chain-of-custody records for all samples, field blanks, and quality control duplicates.

j. For those methods which employ gas chromatography (GC) as the analytical technique (i.e., E601, E602, E608, E617, SW8010, SW8020, etc.), positive identification is required for all analytes having concentrations

higher than the Method Detection Limit (MDL); confirm positive concentrations by second-column GC. Analytes which cannot be confirmed shall be reported as "Not Detected" in the body of the report. Include the results of all second-column GC confirmational analyses in the report appendix along with other raw analytical data.

Base the quantification of confirmed analytes upon first-column analysis. The maximum number of second-column confirmational analyses that will be funded under this task order is fifty percent (50%) of actual field samples (to include field QA/QC samples). The total number of samples for each GC method listed in Attachment 1 includes this allowance.

k. All raw data including QA/QC data and standards shall be archived at the prime contractor's laboratory for a period of not less than five years. Upon request, these data shall be supplied to the USAFOEHL.

3. Health and Safety

The contractor shall comply with USAF, OSHA, EPA, State and local health and safety regulations regarding the proposed work effort. Use EPA guidelines for designating the appropriate levels of protection at study sites. Prepare a written Health and Safety Plan for the proposed work effort and coordinate it directly with applicable regulatory agencies. Provide an information copy of the Health and Safety Plan to the USAFOEHL prior to commencing field operations (i.e., drilling and sampling).

B. In addition to items delineated in A above, conduct the following specific actions at sites specified on MacDill AFB:

1. Former Fuel Storage Area No. 2 (Site B)

a. Perform a geophysical survey utilizing magnetometer and electrical resistivity (ER) techniques, to aid in identifying the horizontal and vertical extent of the site, to locate the buried fuel tanks and to aid in placement of the monitoring wells specified below.

b. Based upon the results of the geophysical survey, emplace one upgradient and three downgradient monitoring wells at the site. Obtain one groundwater sample from each well (4 total) and analyze each sample for purgeable organics, lead, petroleum hydrocarbons and EDB.

c. Install one additional monitoring well between wells MDB-1 and MDB-4 downgradient of the located underground storage tanks.

d. Obtain one groundwater sample from the newly installed well and resample the 4 existing wells. Analyze each sample (total of 5) for parameters listed in Appendix 1, Table 4.

e. Measure and record water levels and specific conductance at high and low tides at all five monitoring wells.

2. Landfill at Dog Kennel (Site 3)

a. Perform a geophysical survey utilizing ER techniques to aid in identifying the extent of any leachate plume and to help define subsurface conditions.

b. Based upon the results of the ER survey, emplace one monitoring well upgradient of the site.

c. Collect three surface water/sediment samples from the ditch crossing the landfill and two surface water and four sediment samples from the ditch that surrounds the landfill.

d. Collect one groundwater sample from the well described in IB2b above, and one sample each from the three existing downgradient monitoring wells at the site.

e. Analyze each sample taken from the site (four groundwater, five surface water, and seven sediment) for purgeable organics, base/neutral and acid extractable organics (GC/MS), and metals scan.

f. Resample the four existing monitoring wells and collect five surface water samples from the creek and ditches around the site. Analyze each sample (total of 9) for parameters listed in Appendix 1, Table 4.

g. Measure and record water levels and specific conductance at high and low tides at the four monitoring wells.

3. Past Landfills (Sites 5-8)

a. Emplace two monitoring wells, each approximately 20 feet deep, upgradient of the landfills.

b. Obtain five surface water/sediment samples from the drainage ditch south of the landfills.

c. Collect two groundwater samples from the wells described in IB3a above, and one sample each from the four existing downgradient monitoring wells at the site.

d. Analyze each sample taken from the site (six groundwater and five surface water/sediment) for purgeable organics, base/neutral and acid extractable organics, and metals scan.

e. Resample the six existing monitoring wells and collect five additional surface water samples from the site. Analyze each sample (total of 11) for parameters listed in Appendix 1, Table 4.

f. Measure and record water levels and specific conductance at high and low tides at the six monitoring wells.

4. Recent Landfill (Site 9)

a. Perform a geophysical survey utilizing ER techniques to aid in identifying the extent of any leachate plume and to help define subsurface conditions at the site.

b. Emplace four monitoring wells, based upon the results of the ER survey, one upgradient and three downgradient of the site.

c. Collect two surface water/sediment samples from the drainage ditch west of the site.

d. Collect one groundwater sample from each of the four new and two pre-existing wells at the site.

e. Analyze each sample taken from the site (six groundwater and two surface water/sediment) for purgeable organics, base/neutral and acid extractable organics, and metals scan.

f. Resample the six existing monitoring wells and collect two additional surface water samples from the drainage ditch west of the site. Analyze each sample (total of 8) for parameters listed in Appendix 1, Table 4.

5. Chemical Munitions Burial Area (Site 11)

a. Because of the unknown waste types and quantities disposed at Site 11, the contractor shall conduct an initial study at this site to consist of review of records and interviews of former and current base personnel. The contractor shall make any recommendations for site monitoring in the first R&I status report following the completion of the records review and interviews.

b. After the initial study, and upon consultation with USAFOEHL, the contractor shall obtain a maximum of three surface water/sediment samples from the canal adjacent to the site and shall analyze the samples for purgeable organic compounds, base/neutral and acid extractable compounds by GC/MS, and metals scan.

c. Perform a geophysical survey. The survey should use electromagnetic methods (EM) or metal detectors to locate metal canisters or drums that are suspected of being buried at this site.

6. Creosote Pit (Site 13)

a. Perform a geophysical survey utilizing ER techniques to locate the exact creosote pit boundaries and identify the extent of any leachate plume.

b. Install three monitoring wells, based on the results of the ER survey, one upgradient and two downgradient of the site.

c. Collect one groundwater sample from each well at the site. Analyze each sample (three total) for base/neutral and acid extractable organic compounds.

7. Fuel Tank Farm (Site 16)

Collect six surface water/sediment samples from the drainage canal and ditch adjacent to the site. Analyze each sample (six total) for lead, petroleum hydrocarbons, purgeable organics and EDB (water only).

8. Drum Storage Area (Site 17)

a. Install one groundwater monitoring well upgradient of the site.

b. Collect one surface water and three sediment samples from the drainage ditch west of the site.

c. Collect groundwater samples from the one upgradient (new) and two downgradient (pre-existing) monitoring wells at the site.

d. Analyze each sample taken from the site (three groundwater and one surface water and three sediment) for purgeable organics, base/neutral and acid extractable organic compounds, lead, cadmium, chromium, and zinc.

e. Install one additional monitoring well downgradient of the site and southeast of well MD 17-1.

f. Obtain one groundwater sample from the newly installed well and resample the 3 existing wells. Collect two surface water samples from the south side of the site. Analyze each sample (total of 6) for parameters listed in Appendix 1, Table 4.

9. Fire Training Area (Site 23)

Site 23 is actually two fire training pits. Each pit will be monitored separately.

a. Perform a geophysical survey using ER techniques to delineate subsurface conditions and to attempt to identify the extent of the leachate plume(s).

b. Install three deep wells into the Floridan Aquifer at Site 23: one upgradient well and one well downgradient from each of the two fire training pits. The locations of these wells shall be carefully determined from the results of the ER study. Each deep well shall be installed by first drilling a 10- or 12-inch diameter borehole into the clay confining layer and centering and grouting a 6- or 8-inch diameter PVC outer casing. The well shall then be completed by drilling a 6-inch diameter hole within the outer casing to an approximate depth of 50 feet. The final well shall be constructed of 2-inch diameter PVC casing. This technique avoids the risk of contaminating the Floridan Aquifer.

c. Install a maximum of eight shallow groundwater monitoring wells at the site. One well shall be emplaced upgradient and a maximum of three downgradient of each fire training pit. One of the upgradient wells shall be constructed with 4-inch diameter casing. The other wells shall be 2-inch diameter.

d. Conduct an aquifer pumping test at the site using the 4-inch well as the pumping well and install one 2-inch shallow well as the observation well. Determine the transmissivity (T) and storativity (S) of the shallow aquifer based upon the pump test results. The drawdown portion of the test shall be approximately 24 hours long, with an 8-hour recovery period. Pumping rates shall be approximately 10 gpm.

e. Collect groundwater samples from each well at the site, the six existing monitoring wells and the eleven (maximum) new monitoring wells. Analyze each sample for purgeable organics, lead and petroleum hydrocarbons. Note the thickness of any fuel layer on each sample.

10. Old Landfill, Avon Park (Site AP-6)

a. Install one groundwater monitoring well upgradient of the site.

b. Collect three surface water/sediment samples from the rim canal that flows across the site. Analyze these three samples for purgeable organics, base/neutral and acid extractable organics, petroleum hydrocarbons, and metals scan.

c. Collect groundwater samples from the one upgradient (new) and three downgradient (existing) monitoring wells at the site. Analyze each sample for purgeable organics, petroleum hydrocarbons, base/neutral and acid extractable organics, and metals scan.

11. Current Landfill, Avon Park (Site AP-7)

a. Install one groundwater monitoring well upgradient of the site.

b. Collect groundwater samples from the one upgradient (new) and three downgradient (existing) monitoring wells at the site. Analyze each sample for purgeable organics, petroleum hydrocarbons, base/neutral and acid extractable organics, and metals scan.

12. Army Test Area, Avon Park (Site AP-9)

Collect ten shallow soil samples from the chemical anticrop (herbicide) test area at Avon Park. Composite one sample from the upper six inches of soil at each sample location. Analyze each sample (10 total) for dioxin and herbicides.

C. Data Review

1. Tabulate field and analytical laboratory results, including field and laboratory parameters and QA/QC data, and incorporate them into the monthly R&D Status Reports. Forward them to the USAFOEHL for review as soon as they become available as specified in Item VI below. Field and laboratory parameters shall include times and dates of sample collection, extraction and analysis.

2. Upon completion of all analyses, tabulate and incorporate all results into an Informal Technical Information Report (Atch 1, Seq 3 as specified in Item VI below) and forward the report to USAFOEHL for review.

3. Data/results, generated throughout this undertaking, indicating a possibility of health risk (for example, contaminated drinking water aquifer) shall be reported immediately via telephone to the USAFOEHL program manager.

D. Reporting

1. Technical Field Operating Plan: The contractor shall develop a Technical Field Operations Plan based upon the technical requirements for the proposed work effort. This plan shall be explicit with regards to field procedures. Include, but do not limit the plan to, field decontamination operations, sampling protocol, QA/QC field and laboratory procedures, field schedule, etc. A guideline for the plan is provided under separate cover. The plan shall be submitted before field operations begin, but no later than three weeks after date of contract award. Ten copies of the plan shall be submitted, as specified in Sequence 19, Item VI.

2. A draft report delineating all findings of this field investigation shall be prepared and forwarded to the USAFOEHL (as specified in Sequence 4, Item VI below) for Air Force review and comment. This report shall include a discussion of the regional/site specific hydrogeology, well and boring logs, data from water level surveys, geophysical surveys, groundwater surface and gradient maps, data from the aquifer test, water quality, sediment and soil analysis results, available geohydrologic cross sections, and laboratory and field quality assurance/quality control information. The report shall follow the USAFOEHL supplied format (mailed under separate cover). The format is an integral part of this delivery order.

3. Results, conclusions and recommendations concerning the sites listed in this task which were produced in the technical report(s) of the previous staged work of IRP Phase II (mailed under separate cover), shall be used in the data reduction to plot any trends and arrive at the conclusions and recommendations of this effort's technical report (Sequence 4, Item VI below). The technical report of this effort shall be accomplished so that the report will reflect the combined up-to-date trend of each of the IRP Phase II sites listed herein.

4. The results section of the report shall include water, sediment and soil analyses results, field quality control sample data, internal laboratory control data (lab blanks, lab spikes, and lab duplicates), and laboratory quality assurance procedures. Provide second column confirmation results and include which columns were used, the conditions, and retention times. Summarize the specific collection techniques, analytical method, holding time, and limit of detection for each analyte (Standard Methods, EPA, etc.).

5. The recommendation section shall address each site and list sites by categories. Category I shall consist of sites where no further action (including remedial action) is required. Data for these sites are considered sufficient to rule out significant public health or environmental hazards.

Category II sites are those requiring additional monitoring or work to quantify or further assess the extent of current or future contamination. Category III sites are sites that will require remedial actions (ready for IRP Phase III or IV actions). Recommendations for Category III sites shall include any possible influence on sites in Categories I and/or II due to their connection to the same hydrological system. Any dependency between sites in different categories shall be clearly stated. The contractor shall include a list of candidate remedial action alternatives including Long Term Monitoring (LTM) as remedial action and corresponding rationale, that, as a minimum, should be considered in selecting the remedial action for a given site. The list shall encompass alternatives that could potentially attain applicable environmental standards. For contaminants that do not have standards, the contractor may use EPA recommended safe levels for noncarcinogens (Health Advisory or Suggested-No-Adverse-Response Levels). If not specifically requested, comprehensive cost or technical analyses of alternatives shall not be included. However, in those situations where field survey data indicate immediate corrective action is necessary, the contractor shall present specific, detailed recommendations. For each category above, the contractor shall summarize the results of field data, environmental or regulatory criteria, or other pertinent information supporting conclusions and recommendations.

6. For those sites in need of additional Phase II effort, identify specific requirements for future monitoring needed to determine the magnitude, extent, and rate and direction of movement of detected contaminants. Identify potential environmental consequences of discovered contamination, where known. Provide estimates of costs by line items for any additional investigation beyond this stage along with estimates of time required to accomplish the investigation. Furnish the cost data in a separately bound appendix to the final report.

E. Meetings

The contractor's project leader shall attend two meetings to take place at times to be specified by the USAFOEHL. The meetings shall take place at MacDill AFB for a duration of one day each.

II. SITE LOCATION AND DATES

MacDill AFB FL
Date to be established

III. BASE SUPPORT

A. The Base Point of Contact (POC) will receive from the contractor the split samples and then select 10% of them, package them, and then deliver them back to the contractor within 24 hours for subsequent overnight shipment to USAFOEHL as stated in paragraph IA2h.

B. Base personnel will assign the disposal points within the installation of all hazardous and nonhazardous drill cuttings, contaminated groundwater, and contaminated sampling equipment.

C. Base personnel will designate an equipment staging area.

D. Base personnel will mark underground utilities where required.

E. Base personnel will designate an equipment decontamination area.

F. The base will provide office space with telephone and access to copy machine.

IV. GOVERNMENT FURNISHED PROPERTY: None

V. GOVERNMENT POINTS OF CONTACT

- | | |
|---------------------------------------|---------------------------------|
| 1. USAFOEHL Technical Program Monitor | 2. Base Monitor |
| 2Lt Dale Dietzel | 2Lt Jeff Mason |
| USAFOEHL/TSS | USAF Regional Hosp MacDill/SGPB |
| Brooks AFB TX 78235-5501 | MacDill AFB FL 33608-5300 |
| AV 240-2158 | AV 968-3534 |
| (512) 536-2158 | (813) 830-3534 |
| | |
| 3. MAJCOM Monitor | |
| Col Jerry Dougherty | |
| HQ TAC/SGPB | |
| Langley AFB VA 23665-5001 | |
| AV 432-3322 | |
| (804) 764-3322 | |

VI. In addition to sequence numbers 1, 5, and 11 in Attachment 1 to the contract, which are applicable to all orders, the sequence numbers listed below are applicable to this order. Also shown are data applicable to this order.

<u>Sequence No.</u>	<u>Para No.</u>	<u>Block 10</u>	<u>Block 11</u>	<u>Block 12</u>	<u>Block 13</u>	<u>Block 14</u>
19 (TOP)	ID1	OTIME	<u>86 Jul 01</u>	<u>86 Aug 04</u>	--	10
<u>2 (Cost)</u>	ID6	OTIME	<u>87 Dec 28</u>	<u>88 Jan 04</u>	--	3
7	IA3	OTIME	<u>86 Jul 01</u>	<u>86 Aug 29</u>		3
3	IC2	OTIME	**	**	--	3
4	ID	ONE/R	<u>86 Feb 06</u>	<u>87 Mar 06</u>	<u>88JAN04</u>	*
14		MONTHLY	<u>86 Jul 29</u>	<u>86 Aug 29</u>	***	3
15		MONTHLY	<u>86 Jul 29</u>	<u>86 Aug 29</u>	***	3

*Two draft reports (25 copies of each) and one final report (50 copies plus the original camera ready copy) are required. Incorporate Air Force comments into the second draft and final reports as specified by the USAFOEHL. Supply the USAFOEHL with a final copy of the first draft, second draft, and final reports for acceptance prior to distribution. Distribute remaining 24 copies of each draft report and 49 copies of the final report as specified by the USAFOEHL.

**Upon completion of the total analytical effort before submission of the first draft report.

***Submit monthly hereafter.

Table 1

ANALYTICAL METHODS, DETECTION LIMITS, AND NUMBER OF SAMPLES

WATER

<u>PARAMETER</u>	<u>METHOD^a</u>	<u>DETECTION LIMIT</u>	<u>NO. SAMPLES</u>	<u>QA</u>	<u>TOTAL SAMPLES</u>
Purgeable Organic Compounds	E601	c	54	5	89 ¹
	602				
	E601	c	19	2	32 ¹
	SW5030/ SW8020 ^b				
Base/Neutral and Acid Extractable Organic Compounds	E625	d	<u>50</u>	5	<u>55</u>
1,2-Dibromoethane (EDB)	E502.1	c	10	1	17 ¹
Petroleum Hydrocarbons	E418.1	100µg/l	38	4	42
Cadmium (Cd)	E213.2	0.0005mg/l ^e	4	1	5
Chromium (Cr)	E218.2	0.05mg/l ^e	1	1	5
Lead (Pb)	E239.2	0.005mg/l ^e	31	3	34
Zinc (Zn)	E289.1	0.02mg/l ^e	4	1	5
Metals Scan	E200.7	f	<u>43</u>	4	<u>47</u>

SOILS

<u>PARAMETER</u>	<u>METHOD^A</u>	<u>DETECTION LIMIT</u>	<u>NO. SAMPLES</u>	<u>QA</u>	<u>TOTAL SAMPLES</u>
Purgeable Organic Compounds	SW5030/ SW8240	d	29	3	32
Base/Neutral and Acid Extractable Organic Compounds	SW3550/ SW8270	d	23	2	25
Herbicides	SW8150	c	10	1	17 ¹
Dioxin (2,3,7,8 TCDD)	SW3550/ SW8280	d	10	1	11

Appendix 1

SOILS

<u>PARAMETER</u>	<u>METHOD^a</u>	<u>DETECTION LIMIT</u>	<u>NO. SAMPLES</u>	<u>QA</u>	<u>TOTAL SAMPLES</u>
Petroleum Hydrocarbons	SW3550/ E418.1	100mg/kg	9	1	10
Metals Scan	SW1310/ SW6010 & SW7471	g	20	2	22
Cadmium (Cd)	SW3050/ SW7130	2.5mg/kg ^e	3	1	4
Chromium (Cr)	SW3050/ SW7190	25mg/kg ^e	3	1	4
Lead (Pb)	SW3050/ SW7420	50mg/kg ^e	9	1	10
Zinc (Zn)	SW3050/ SW7950	2.5mg/kg ^e	3	1	4
EP Toxicity	SW-846	h	10	1	11

^aMethod references are as follows:

"E" Methods: E501 through E503 Methods
USEPA
Environmental Monitoring and Support Laboratory
Cincinnati OH 45268
November 6, 1979

E600 Series Methods
Methods for Organic Chemical Analysis of Municipal and
Industrial Wastewater
USEPA
Federal Register, Vol 49, No 209, 26 Oct 1984

E200.7 Method
Inductively Coupled Plasma-Atomic Emission Spectrometer
Method for Trace Element Analysis of Water and Wastes
USEPA
Federal Register, Vol 49, No 209, 26 Oct 1984

"SW" Methods: Test Methods for Evaluating Solid Waste, Physical/Chemical
Methods, SW-846, 2nd Edition (USEPA, 1984)

^bPurgeable aromatic compounds shall be analyzed using method SW8020 at Sites No. 3, "B", and 16, so that xylene can be included among the analytes. All other analyses for purgeable aromatics shall be by method E602.

^cDetection limits for all parameters analyzed by GC shall be as stated in the respective methods. Report results for organics in water as µg/l; in soil as mg/kg. Positive identification is required for all analytes having concentrations higher than the method detection limit; confirm positive concentrations by second-column GC. Analytes which cannot be confirmed shall be reported as "Not Detected" in the body of the report. Include the results of both first and second-column data in the appendix of the report. Base the quantification of confirmed analytes upon the first-column analysis.

^dDetection limits for all parameters analyzed by GC/MS shall be as stated in the respective methods. Report results for organics in water as µg/l; in soil as mg/kg.

^eReport results for metals in water as mg/l; in soil as mg/kg. Report no more than two significant figures for any metals concentration.

^fMetals scan in water shall consist of an ICP scan for priority pollutant and other metals using E200.7 as follows:

Element	Estimated Detection Limit, mg/l
Aluminum	0.10
*Arsenic	0.01
*Antimony	0.35
Barium	0.05
Beryllium	0.05
Boron	0.05
Cadmium	0.01
Calcium	0.045
Chromium	0.05
Cobalt	0.05
Copper	0.05
Iron	0.05
*Lead	0.01
Magnesium	0.035
Manganese	0.05
*Molybdenum	0.05
Nickel	0.10
Potassium	0.10
*Selenium	0.01
Silica (SiO ₂)	0.10
Silver	0.05
Sodium	1.0
Thallium	0.05
Vanadium	0.05
Zinc	0.05

plus method E245.1 for mercury, with a detection limit of 0.0002 mg/l. Report all results as mg/l.

*To meet the detection limits, five metals were analyzed by graphite furnace AAS instead of ICPEs: As (E206.2), Sb (E204.2), Se (E207.2), Pb (E239.2), Mo (246.2).

⁸Metals Scan in soil/sediment shall consist of an extraction by SW1310 (EP Toxicity) and analysis by SW6010 (ICAP) and SW7471 (for mercury), as follows:

<u>Metal</u>	<u>Detection Limits</u> <u>(mg/l of extract)</u>
*Arsenic	0.002
Barium	0.10
Cadmium	0.005
Chromium	0.05
*Lead	0.05
Mercury	0.0002
*Selenium	0.01
Silver	0.01

*To meet the detection limits, three metals were analyzed by graphite furnace AAS instead of ICPEs: As (SW7060), Se (SW7140), Pb (SW7421).

^hEP Toxicity in soil (contaminated drill cuttings) shall be determined using procedures specified in SW-846, Test Methods for Evaluating Solid Wastes, 2nd Ed.

ⁱTotal number of samples includes second-column confirmation on 50% of field samples (to include the field QC samples).

Purgeable Organic Compounds - EPA Methods 601-602, 8010-8020, and 8240.

Benzene	trans-1,2-Dichloroethene
Bromodichloromethane	1,2-Dichloropropane
Bromoform	cis-1,3-Dichloropropene
Bromomethane	trans-1,3-Dichloropropene
Carbon tetrachloride	Ethyl benzene
Chlorobenzene	Methylene chloride
Chloroethane	1,1,2,2-Tetrachloroethane
2-Chloroethylvinyl ether	Tetrachloroethene
Chloroform	Toluene
Chloromethane	1,1,1-Trichloroethane
Dibromochloromethane	1,1,2-Trichloroethane
1,2-Dichlorobenzene	Trichloroethene (TCE)
1,3-Dichlorobenzene	Trichlorofluoromethane
1,4-Dichlorobenzene	Vinyl chloride
1,1-Dichloroethane	ortho, meta and para xylene
1,2-Dichloroethane	(8020 only)
1,1-Dichloroethene	

Herbicides - Method SW 8150

2,4-D
2,4-DB
2,4,5-T
2,4,5-TP (Silvex)
Dalapon
Dicamba
Dichloroprop
Dinoseb
MCPA
MCPB

Extractables - EPA Methods 625 and 8270

Base/Neutral Extractables

Acenaphthene
 Acenaphthylene
 Anthracene
 Aldrin PCB-1016
 Benzo(a)anthracene
 Benzo(b)fluoranthene
 Benzo(k)fluoranthene
 Benzo(a)pyrene
 Benzo(ghi)perylene
 Benzyl butyl phthalate
 β -BHC Phenanthrene
 δ -BHC Pyrene
 Bis(2-chloroethyl)ether
 Bis(2-chloroethoxy)methane
 Bis(2-ethylhexyl)phthalate
 Bis(2-chloroisopropyl)ether
 4-Bromophenyl phenyl ether
 Chlordane 4-Chloro-3-methylphenol
 2-Chloronaphthalene
 4-Chlorophenyl phenyl ether
 Chrysene 2,4-Dimethylphenol
 4,4'-DDD 2,4-Dinitrophenol
 4,4'-DDE 2-Methyl-4,6-dinitrophenol
 4,4'-DDT 2-Nitrophenol
 Dibenzo(a,h)anthracene
 Di-n-butylphthalate
 1,3-Dichlorobenzene
 1,2-Dichlorobenzene
 1,4-Dichlorobenzene
 3,3'-Dichlorobenzidine
 Dieldrin
 Diethyl phthalate
 Dimethyl phthalate
 2,4-Dinitrotoluene
 2,6-Dinitrotoluene
 Di-n-octylphthalate
 Endosulfan sulfate
 Endrin aldehyde
 Fluoranthene
 Fluorene
 Heptachlor
 Heptachlor epoxide
 Hexachlorobenzene
 Hexachlorobutadiene
 Hexachloroethane
 Indeno(1,2,3-cd)pyrene
 Isophorone

Naphthalene
 Nitrobenzene
 N-Nitrosodi-n-propylamine

PCB-1221
 PCB-1232
 PCB-1242
 PCB-1248
 PCB-1254
 PCB-1260

Toxaphene
 1,2,4-Trichlorobenzene

Acid Extractables

2-Chlorophenol
 2,4-Dichlorophenol

 4-Nitrophenol
 Pentachlorophenol
 Phenol
 2,4,6-Trichlorophenol

Appendix 1

Table 2

ANALYSES BY SITE - MAC DILL AFB
WATER

ANALYTE	SITE "B"	SITE 3	SITES 5-8	SITE 9	SITE 11	SITE 13	SITE 16	SITE 17	SITE 23	SITE AP-6	SITE AP-7	SITE AP-9
URGABLE ORGANICS (E601&602)			11	8	3			4	17	7	4	
URGABLE ORGANICS (E601&SW8020)	4	9					6					
BASE/NEUTRAL AND ACID EXTRACT- ABLE ORGANICS (E625)		9	11	8	3	3		4		7	4	
ADB (E502.1)	4					6						
PETROLEUM HYDROCARBONS (E418.1)	4						6		17	7	4	
CADMIUM (E213.2)								4				
CHROMIUM (E218.2)								4				
LEAD (E239.2)	4						6	4	17			
ZINC (E289.1)								4				
METAL SCAN (E200.7)		9	11	8	3					7	4	

to meet the detection limits, five metals were analyzed by graphite furnace AAS instead of ICPEs: AS (E206.2), (E204.2), SE (E207.2), Pb (E239.2), Mo (246.2).

Table 3

ANALYSES BY SITE - MAC DILL AFR
SOILS

ANALYTE	SITE "B"	SITE 3	SITES 5-8	SITE 9	SITE 11	SITE 13	SITE 16	SITE 17	SITE 23	SITE AP-6	SITE AP-7	SITE AP-9
PURGEABLE ORGANICS (SW8240)		7	5	2	3		6	3		3		
BASE/NEUTRAL AND ACID EXTRACTABLE ORGANICS (SW8270)		7	5	2	3			3		3		
HERBICIDES (SW8150)												10
DIOXIN (SW3550/SW8280)												10
PETROLEUM HYDROCARBONS (SW3550/EH18.1)							6			3		
*METALS SCAN (SW1310/SW6010 & SW7471)		7	5	2	3					3		
CADMIUM (SW3050/SW7130)								3				
CHROMIUM (SW3050/SW7190)								3				
LEAD (SW3050/SW7420)							6	3				
ZINC (SW3050/SW7950)								3				

*To meet the detection limits, three metals were analyzed by graphite furnace AAS instead of ICPEs: As (SW7060), Se (SW7740), Pb (SW7421).

•Revised 07 Jul 87

Table 4 *

ANALYSES BY SITE - MAC DILL AFB
WATER

Parameters	Method	Site "B"	Site 3	Sites 5-8	Site 9	Site 17	No. Samples	QA	2nd Col	Total Samples
Purgeable Halocarbons	E601	5	-	11	8	6	30	3	16	48
Purgeable Aromatics	E602	-	-	11	8	6	25	3	14	42
Petroleum Hydrocarbons	E418.1	5	-	-	-	-	5	1	-	6
Extractable Priority Pollutants	E625	-	9	11	8	6	34	3	-	37
Aromatic Volatile Organics	SW5030/SW8020	5	-	-	-	-	5	1	3	9
Lead	E239.2	5	-	-	-	-	5	1	-	6

Appendix 1

APPENDIX H
CHAIN OF CUSTODY FORMS

CHAIN OF CUSTODY FORMS

OCTOBER 1986 SAMPLING

CHAIN OF CUSTODY RECORD

PROJECT NAME/LOCATION

MacDill AFB Tampa Fla.

SAMPLEN(8): (Signature)

Walter J. Duncan

SAMPLE DESCRIPTION

BRIEFING

REMARKS

SHIP TO:

ANALYST REQUIRED

NO. OF COM-

8020	8020
5030	5030
502.1	502.1
502	502
601	601

ENGINEERING SCIENCE, INC.
1987 Tullia Circle
~~Suite 105~~
Atlanta, GA 30329
~~1987 225-5022~~

H-1

ENGINEERING-SCIENCE

CHAIN OF CUSTODY RECORD

H-2

2538

CHAIN OF CUSTODY RECORD

Distribution: Original Accompanies Shipment, Copy to Coordinator Field Files

ENGINEER'S - SCIENCE

CHAIN OF CUSTODY RECORD

SAYDZ, GA

Distribution: Original Accompanies Shipment, Copy to Coordinator Field Files

~~SA~~ TALLAHASSEE

SHIP TO:

ENGINEERING-8 SCIENCE, INC.
1687 Tullie Circle
Suite 105
Atlanta, GA. 30320
(404) 325-5923

TALLAHASSEE

CHAIN OF CUSTODY RECORD

SHIP TO:
ENGINEERING-8SCIENCE, INC.
1887 Tullie Circle
Suite 106
Atlanta, GA. 30329
(404) 326-6923

TALLAHASSEE

CHAIN OF CUSTODY RECORD

[illegible]

CHAIN OF CUSTODY RECORD SAVANNAH GA

Distribution: Original Accompanying Shipment, Copy to Coordinator Field Files

CHAIN OF CUSTODY RECORD TALAHASSEE

H-9

CHAIN OF CUSTODY RECORD

H-10

CHAIN OF CUSTODY RECORD

H-11

CHAIN OF CUSTODY RECORD

H-12

CHAIN OF CUSTODY RECORD

25627

CHAIN OF CUSTODY RECORD TALLAHASSEE

H-14

CHAIN OF CUSTODY RECORD TALLAHASSEE

H-15

CHAIN OF CUSTODY RECORD

H-16

CHAIN OF CUSTODY RECORD TALLAHASSEE

H-17

CHAIN OF CUSTODY RECORD SAVANNAH

575

CHAIN OF CUSTODY RECORD ~~TALLAHASSEE~~

H-19

CHAIN OF CUSTODY RECORD

595

CHAIN OF CUSTODY RECORD SAVANNAH

250

CHAIN OF CUSTODY RECORD SAVANNAH

556

CHAIN OF CUSTODY RECORD

Date/Time	Remarks
9/16/86	9:35 am

CHAIN OF CUSTODY RECORD

595

CHAIN OF CUSTODY RECORD

TALLAHASSEE

ES JOB NO.	PROJECT NAME/LOCATION	SHIP TO:	ANALYSES REQUIRED	NO. OF CONTAINERS	DATE	TIME	SAMPLE DESCRIPTION	REMARKS
AT001	MacDill AFB, Tampa, FL	ENGINEERING-SCIENCE, INC. 1687 Tullie Circle Suite 106 Atlanta, GA. 30329 (404) 325-5923						
SAMPLER(S): (Signature)								
(Signature)								
10/16	0930	FA MD23-1	GW	ES	6	33	FUEL ORDER	
10/16	1300	FA MD23-3	GW	ES	6	33	"	"
10/16	1200	FA MD23-2	GW	ES	6	33	"	"
10/16	1415	FA MD23-7	GW	ES	6	33	"	"
10/16	1515	FA MD23-8	GW	ES	6	33	"	"
10/16	1600	FA MD23-9	GW	ES	6	33	"	"
10/16	1615	FA MD23-16	GW	CEHL	6	33	"	"
		All these samples have been analyzed by JANU 23 - 16 on the same day.						
Relinquished by: (Signature)		Date/Time	Received by: (Signature)		Date/Time	Received by: (Signature)		
(Signature)		10/16 1900	David Curry 815		10/17			
Relinquished by: (Signature)		Date/Time	Received for Laboratory by: (Signature)		Date/Time	Remarks		
(Signature)								

SAVA WAH

CHAIN OF CUSTODY RECORD

5/9/97

CHAIN OF CUSTODY RECORD

9/25

ENGINEERING-SCIENCE

CHAIN OF CUSTODY RECORD

SAVANNAH

[illegible]

CHAIN OF CUSTODY RECORD

H-30

CHAIN OF CUSTODY RECORD

H-31

CHAIN OF CUSTODY RECORD

5A2224H

Ch 9

H-33

CHAIN OF CUSTODY RECORD

1142224750

H-34

ENGINEERING-SCIENCE

CHAIN OF CUSTODY RECORD

TALAHASSEE

[illegible]

TALLAHASSEE

CHAIN OF CUSTODY RECORD

H-36

CHAIN OF CUSTODY RECORD

H-37

CHAIN OF CUSTODY RECORD TALLAHASSEE

H-38

CHAIN OF CUSTODY RECORD

CHAIN OF CUSTODY RECORD

2656

CHAIN OF CUSTODY RECORD

H-40

CHAIN OF CUSTODY RECORD TAWA WASSSEE

H-44

CHAIN OF CUSTODY RECORD

H-46

CHAIN OF CUSTODY RECORD

H-47

CHAIN OF CUSTODY RECORD

H-48

CHAIN OF CUSTODY RECORD

H-49

ENGINEERING-SCIENCE

CHAIN OF CUSTODY RECORD

EB JOB NO.		PROJECT NAME/LOCATION		SHIP TO:	
AT001		MAC DILL AFB, TAMPA, FL		ENGINEERING-SCIENCE, INC. 1687 Tullie Circle Suite 106 Atlanta, GA. 30329 (404) 325-8923	
SAMPLER(S): (Signature)				ANALYSES REQUIRED	
Walker Duncan					

CHAIN OF CUSTODY RECORD

2/9/8

ALVANASSE

CHAIN OF CUSTODY RECORD

H-54

CHAIN OF CUSTODY RECORD

H-55

CHAIN OF CUSTODY RECORD

7/26/77

CHAIN OF CUSTODY RECORD

H-59

CHAIN OF CUSTODY RECORD

H-60

CHAIN OF CUSTODY RECORD

Tallahassee

H-61

CHAIN OF CUSTODY RECORD

Shovan

[illegible]

CHAIN OF CUSTODY RECORD

[illegible]

CHAIN OF CUSTODY RECORD

437

CHAIN OF CUSTODY RECORD

Tallahassee

H-65

CHAIN OF CUSTODY RECORD

H-66

CHAIN OF CUSTODY RECORD

Tallahassee

H-67

CHAIN OF CUSTODY RECORD

Tallahassee

[illegible]

CHAIN OF CUSTODY RECORD

Savannah

[illegible]

CHAIN OF CUSTODY RECORD

3

CHAIN OF CUSTODY RECORD

Talghasse

CHAIN OF CUSTODY RECORD

Tallahassee

H-73

CHAIN OF CUSTODY RECORD

Tallahassee


[illegible]

CHAIN OF CUSTODY RECORD

H-76

CHAIN OF CUSTODY RECORD

Savannah



CHAIN OF CUSTODY RECORD

H-79

CHAIN OF CUSTODY FORMS

AUGUST 1987 SAMPLING

ENGINEERING-SCIENCE

CHAIN OF CUSTODY RECORD

[illegible]

CHAIN OF CUSTODY RECORD

the first two groups of subjects, the subjects in the third group were not asked to perform any task during the 10 min rest period.

ENGINEERING-SCIENCE

CHAIN OF CUSTODY RECORD

H-82

ENGINEERING-SCIENCE

CHAIN OF CUSTODY RECORD

872427

PROJECT NAME/LOCATION MacDILL AFB, FLORIDA		SHIP TO: SAVANNAH LABS 2820 Industrial Plaza Blvd. Tallahassee, Florida 32301																																																													
ES JOB NO. AT001	SAMPLER(S): (Signature) Pharon & Schultz	NO. OF CONTAINERS	ANALYSES REQUIRED																																																												
DATE	TIME	SAMPLE DESCRIPTION	REMARKS																																																												
8/13/87	1230	MD SB-3 6W, ES	Strong 17 S small																																																												
8/13/87	1245	MD SW SB-3 6W, ES	" " " "																																																												
8/13/87	1415	MD SW SB-4, ES	" " " "																																																												
8/13/87	1445	MD SB-4 6W, ES	" " " "																																																												
8/13/87	1500	MD SW SB-5, ES	" " " "																																																												
<table border="1"> <thead> <tr> <th>NO.</th> <th>OF</th> <th>CON-</th> <th>TAINERS</th> <th>E601</th> <th>E602</th> <th>E418.1</th> <th>E625</th> <th>SW5030/8020</th> <th>E239.2</th> </tr> </thead> <tbody> <tr> <td>6</td> <td></td> <td></td> <td></td> <td>X</td> <td>X</td> <td>X</td> <td>X</td> <td></td> <td></td> </tr> <tr> <td>6</td> <td></td> <td></td> <td></td> <td>X</td> <td>X</td> <td>X</td> <td>X</td> <td></td> <td></td> </tr> <tr> <td>6</td> <td></td> <td></td> <td></td> <td>X</td> <td>X</td> <td>X</td> <td>X</td> <td></td> <td></td> </tr> <tr> <td>6</td> <td></td> <td></td> <td></td> <td>X</td> <td>X</td> <td>X</td> <td>X</td> <td></td> <td></td> </tr> <tr> <td>6</td> <td></td> <td></td> <td></td> <td>X</td> <td>X</td> <td>X</td> <td>X</td> <td></td> <td></td> </tr> </tbody> </table>				NO.	OF	CON-	TAINERS	E601	E602	E418.1	E625	SW5030/8020	E239.2	6				X	X	X	X			6				X	X	X	X			6				X	X	X	X			6				X	X	X	X			6				X	X	X	X		
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ES JOB NO. AT001		PROJECT NAME/LOCATION MacDILL AFB, FLORIDA		NO. OF CON- TAINERS	ANALYSES REQUIRED					SHIP TO:	
SAMPLER(S): (Signature) <i>Sharon A. Schultz</i>		SAMPLE DESCRIPTION			E601	E602	E418.1	E625	SW5030/8020	E239.2	SAVANNAH LABS 2820 Industrial Plaza Blvd. Tallahassee, Florida 32301
DATE	TIME										REMARKS
8/14/87	1500	MD B-2, 6W, ES ✓		7	X	X	X	X	X		
8/14/87	1600	MD 17-4, 6W, ES ✓		6	X	X	X	X	X		
8/14/87	1630	MD BL-1, 6W, ES		9	X	X	X	X	X		
Relinquished by: (Signature) <i>Fred R. Plummer</i>		Date/Time 8/14/87 1800	Received by: (Signature) <i>Sharon A. Schultz</i>		8-17-87 9:30a	Relinquished by: (Signature) <i>Sharon A. Schultz</i>		8-17-87 4:00p	Date/Time	Received by: (Signature)	
Relinquished by: (Signature)		Date/Time	Received for Laboratory by: (Signature) <i>K. A. ...</i>		8/14/87	Date/Time		Remarks			

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APPENDIX I
ANALYTICAL QA/QC DATA

APPENDIX I
ANALYTICAL QA/QC DATA

This appendix contains summary tables of information related to the quality of analytical results obtained during the IRP-Phase II, Stage 2 study at MacDill AFB. Table I.1 and I.2 present the analytical methods used and the target method detection limits achieved by the laboratory. Tables I.3 through I.6 list sequentially all water, sediment, and soil samples collected during the investigation, along with the holding times for each analysis performed. Tables I.7 and I.8 summarize the analytical results for blind field duplicate and blank samples submitted for quality assurance (QA) purposes. Tables I.9 and I.10 provide results of the laboratory's internal quality control (QC) analyses. These QC results were obtained from routine analyses of blank, duplicate and matrix spike samples. Tables I.11 and I.12 summarize the holding times for water samples collected August 1987. Tables I.13 and I.14 summarize QA/QC results for samples collected August 1987.

TABLE I.1
SUMMARY OF CHEMICAL ANALYTICAL
METHODS, MAXIMUM HOLDING TIMES AND DETECTION LIMITS
FOR WATER SAMPLES

Analyte	Target Detection Limit
Purgeable Halocarbons	
<u>EPA Method 601 (ug/L)</u>	
Maximum Holding Time: 14 Days	
Bromodichloromethane	0.4
Bromoform	1
Bromomethane	1
Carbon Tetrachloride	0.3
Chlorobenzene	1
Chloroethane	0.8
2-Chloroethylvinyl Ether	1
Chloroform	0.2
Chlormethane	1
Dibromochloromethane	0.5
1,2-Dichlorobenzene	0.5
1,3-Dichlorobenzene	0.5
1,4-Dichlorobenzene	0.5
Dichlorodifluoromethane	1
1,1-Dichloroethane	0.3
1,2-Dichloroethane	0.2
1,1-Dichloroethylene	0.4
trans-1,2-Dichloroethene	0.3
1,2-Dichloropropane	0.5
cis-1,3-Dichloropropene	0.2
trans-1,3-Dichloropropene	0.2
Methylene Chloride	0.5
1,1,2,2-Tetrachloroethane	0.5
Tetrachloroethylene	0.2
1,1,1-Trichloroethane	0.3
1,1,2-Trichloroethane	0.3
Trichloroethylene	0.2
Trichlorofluoromethane	0.5
Vinyl Chloride	1

TABLE I.1
SUMMARY OF CHEMICAL ANALYTICAL
METHODS, MAXIMUM HOLDING TIMES AND DETECTION LIMITS
FOR WATER SAMPLES
(Continued)

Analyte	Target Detection Limit
<u>Purgeable Aromatics</u> <u>EPA Method 602 (ug/L)</u>	
Maximum Holding Time: 7 Days (without acid preservation)	
Benzene	0.5
Chlorobenzene	1
1,2-Dichlorobenzene	0.5
1,3-Dichlorobenzene	0.5
1,4-Dichlorobenzene	0.5
Ethylbenzene	1
Toluene	1
<u>Aromatic Volatile Organics</u> <u>EPA Method 8020 (ug/L)</u>	
Maximum Holding Time: 14 Days	
Benzene	0.5
Chlorobenzene	1
1,2-Dichlorobenzene	0.5
1,3-Dichlorobenzene	0.5
1,4-Dichlorobenzene	0.5
Ethylbenzene	1
Toluene	1
Xylene	1
<u>1,2-Dibromoethane (EDB)</u> <u>EPA Method 502.1 (ug/L)</u>	
Maximum Holding Time: 14 Days	
1,2-Dibromoethane	0.02
<u>Petroleum Hydrocarbons</u> <u>EPA Method 418.1 (mg/L)</u>	
Maximum Holding Time: 28 Days	
Total Hydrocarbons by IR	0.1

TABLE I.1
SUMMARY OF CHEMICAL ANALYTICAL
METHODS, MAXIMUM HOLDING TIMES AND DETECTION LIMITS
FOR WATER SAMPLES
(Continued)

Analyte	Target Detection Limit
Base/Neutral and Acid Extractable Organics <u>EPA Method 625 (ug/L)</u>	
Maximum Holding Times: 7 Days for Extraction 40 Days for Analysis	
Acenaphthene	1.5
Acenaphthylene	1.5
Anthracene	2
Aldrin	10
Benzo (a) Anthracene	10
Benzo (b) Fluoranthene	50
Benzo (k) Fluoranthene	50
Benzo (a) Pyrene	50
Benzo(g,h,i)Perylene	50
Benzyl Butyl Phthalate	25
Beta-BHC	10
Delta-BHC	10
Bis (2-Chloroethyl) Ether	5
Bis (2-Chloroethoxy) Methane	2
Bis (2-Ethylhexyl) Phthalate	20
Bis (2-Chloroisopropyl) Ether	3.5
4-Bromophenyl Phenyl Ether	1.6
Chlorane	20
2-Chloronaphthalene	1.5
4-Chlorophenyl Phenyl Ether	5
Chrysene	10
4,4'-DDD	10
4,4'-DDE	30
4,4'-DDT	10
Dibenzo (a,h) Anthracene	50
Di-N-Butyl Phthalate	3
1,3-Dichlorobenzene	5
1,2-Dichlorobenzene	5
1,4-Dichlorobenzene	5
3,3-Dichlorobenzidine	50
Dieldrin	10
Diethyl Phthalate	5
Dimethyl Phthalate	2
2,4-Dinitrotoluene	3.5
2,6-Dinitrotoluene	3.5
Di-N-Octyl Phthalate	50

TABLE I.1
SUMMARY OF CHEMICAL ANALYTICAL
METHODS, MAXIMUM HOLDING TIMES AND DETECTION LIMITS
FOR WATER SAMPLES
(Continued)

Analyte	Target Detection Limit
Base/Neutral and Acid Extractable Organics (continued)	
<u>EPA Method 625 (ug/L)</u>	
Endosulfan Sulfate	100
Endrin Aldehyde	10
Fluoranthrene	3
Fluorene	1.5
Heptachlor	10
Heptachlor Epoxide	10
Hexachlorobenzene	1.2
Hexachlorobutaidene	1.5
Hexachloroethane	3.5
Indeno (1,2,3-cd) Pyrene	50
Isophorone	3
Naphthalene	1.5
Nitrobenzene	3
N-Nitrosodi-N-Propylamine	2.5
PCB-1016	100
PCB-1221	100
PCB-1232	100
PCB-1242	100
PCB-1248	100
PCB-1254	100
PCB-1260	100
Phenanthrene	2
Pyrene	5
Toxaphene	200
1,2,4-Trichlorobenzene	4
4-Chloro-3-Methylphenol	5
2-Chlorophenol	5
2,4-Dichlorophenol	4
2,4-Dimethylphenol	4
2,4-Dinitrophenol	50
2-Methyl-4,6-Dinitrophenol	20
2-Nitrophenol	6.5
4-Nitrophenol	3.5
Pentachlorophenol	15
Phenol	10
2,4,4-Trichlorophenol	3

TABLE I.1
SUMMARY OF CHEMICAL ANALYTICAL
METHODS, MAXIMUM HOLDING TIMES AND DETECTION LIMITS
FOR WATER SAMPLES
(Continued)

Analyte	Target Detection Limit
Metals Scan	
EPA Methods 200.7 and 245.1 (mg/L)	
Maximum Holding Time: 6 Months	
Aluminum	0.10
*Arsenic	0.01
*Antimony	0.35
Barium	0.05
Beryllium	0.05
Boron	0.05
Cadmium	0.01
Calcium	0.045
Chromium	0.05
Colbalt	0.05
Copper	0.05
Iron	0.05
*Lead	0.01
Magnesium	0.035
Manganese	0.05
*Molybdenum	0.05
Nickel	0.10
Potassium	0.10
*Selenium	0.01
Silica	0.10
Silver	0.05
Sodium	1.0
Thallium	0.50
Vanadium	0.05
Zinc	0.05
Mercury (245.1) ²	<0.0002

* To meet target detection limits, five metals were analyzed by graphite furnace AAS instead of ICPEs: AS (206.2), Sb (204.2), Se (270.2), Pb (239.2), and Mo (246.2).

² Holding time for mercury analysis (245.1) is 28 days.

TABLE I.1
SUMMARY OF CHEMICAL ANALYTICAL
METHODS, MAXIMUM HOLDING TIMES AND DETECTION LIMITS
FOR WATER SAMPLES
(Continued)

Analyte	Target Detection Limit
<u>Metals</u>	
<u>EPA Methods 239.2, 213.2, 218.2, 289.1 (mg/L)</u>	
Maximum Holding Time: 6 Months	
Lead (239.2)	0.005
Cadmium (213.2)	0.0005
Chromium (218.2)	0.05
Zinc (289.1)	0.02

TABLE I.2
SUMMARY OF CHEMICAL ANALYTICAL
METHODS, MAXIMUM HOLDING TIMES AND DETECTION LIMITS
FOR SOIL WATER SAMPLES

Analyte	Target Detection Limit
Volatile Organics	
<u>SW Method 5030/8240 (ug/kg dw)</u>	
Maximum Holding Time: 14 days	
Chloromethane	15
Bromomethane	15
Vinyl Chloride	15
Chloroethane	12
Methylene Chloride	7.5
Trichlorofluoromethane	7.5
1,1-Dichloroethene	6
1,1-Dichloroethane	4.5
trans-1,2-Dichloroethene	4.5
Chloroform	3
1,2-Dichloroethane	3
1,1,1-Tetrachloride	4.5
Carbon Tetrachloride	4.5
Bromodichloromethane	6
1,2-Dichloropropane	7.5
trans-1,3-Dichloropropene	7.5
Trichloroethene	3
Benzene	7.5
Dibromochloromethane	5
1,1,2-Trichloroethane	4.5
cis-1,3-Dichloropropene	3
2-Chloroethylvinyl Ether	15
Bromoform	15
1,1,2,2-Tetrachloroethane	5
Tetrachloroethane	3
Toluene	15
Chlorobenzene	15
Ethylbenzene	15
1,3-Dichlorobenzene	7.5
1,2-Dichlorobenzene	7.5
1,4-Dichlorobenzene	7.5

TABLE I.2
SUMMARY OF CHEMICAL ANALYTICAL
METHODS, MAXIMUM HOLDING TIMES AND DETECTION LIMITS
FOR SOIL WATER SAMPLES
(Continued)

Analyte	Target Detection Limit
Semivolatile Organics	
SW Method 3550/8270 (ug/kg dw)	
Maximum Holding Time: 14 days for extraction 40 days for analysis	
1,3-Dichlorobenzene	125
1,4-Dichlorobenzene	125
Hexachloroethane	90
Bis (2-Chloroethyl) Ether	125
1,2-Dichlorobenzene	125
Bis (2-Chloroisopropyl) Ether	90
N-Nitrosodi-N-Propylamine	60
Nitrobenzene	75
Hexachlorobutadiene	40
1,2,4-Trichlorobenzene	100
Isophorone	75
Naphthalene	40
Bis (2-Chloroethoxy) Methane	50
Hexachlorocyclopentadiene	75
2-Chloronaphthalene	40
Acenaphthylene	40
Acenaphthene	40
Dimethyl Phthalate	50
2,6-Dinitrotoluene	90
Fluorene	40
4-Chlorophenyl Phenyl Ether	125
2,4-Dinitrotoluene	90
Diethyl Phthalate	125
N-Nitrosodiphenylamine	125
Hexachlorobenzene	30
Gamma-BHC	250
4-Bromophenyl Phenyl Ether	40
Delta-BHC	250
Phenanthrene	50
Anthracene	50
Beta-BHC	250
Heptachlor	250
Alpha-BHC	250
Aldrin	250
Dibutyl Phthalate	75
Heptachlor Epoxide	250

TABLE I.2
SUMMARY OF CHEMICAL ANALYTICAL
METHODS, MAXIMUM HOLDING TIMES AND DETECTION LIMITS
FOR SOIL WATER SAMPLES
(Continued)

Analyte	Target Detection Limit
Semivolatile Organics (continued)	
<u>SW Method 3550/8270 (ug/kg dw)</u>	
Endosulfan I	250
Fluoranthene	75
Dieldrin	250
4,4'DDE	750
Pyrene	125
Endrin	250
Endosulfan II	250
4,4'-DDD	250
Benzidine	1,250
4,4'-DDT	250
Endosulfan Sulfate	2,500
Endrin Aldehyde	250
Butyl Benzyl Phthalate	625
Bis (2-Ethylhexyl) Phthalate	500
Chrysene	250
Benzo(a)Anthracene	250
3,3-Dichlorobenzidine	1,250
Di-N-Octyl Phthalate	1,250
Benzo(b)Fluoranthene	1,250
Benzo(k)Fluoranthene	1,250
Benzo(a)Pyrene	1,250
Ideno(1,2,3-cd)Pyrene	1,250
Dibenzo(a,h)Anthracene	1,250
Benzo(g,h,k)Pyrene	1,250
N-Nitrosodimethylamine	1,250
Chlordane	500
Toxaphene	5,000
PCB-1016	2,500
PCB-1221	2,500
PCB-1232	2,500
PCB-1242	2,500
PCB-1248	2,500
PCB-1254	2,500
PCB-1260	2,500
2-Chlorophenol	125
2-Nitrophenol	160
Phenol	250
2,4-Dimethylphenol	100
2,4-Dichlorophenol	100

TABLE I.2
SUMMARY OF CHEMICAL ANALYTICAL
METHODS, MAXIMUM HOLDING TIMES AND DETECTION LIMITS
FOR SOIL WATER SAMPLES
(Continued)

Analyte	Target Detection Limit
<u>Semivolatile Organics (continued)</u>	
<u>SW Method 3550/8270 (ug/kg dw)</u>	
2,4,6-Trichlorophenol	75
4-Chloro-3-Methylphenol	125
2,4-Dinitrophenol	1,250
2-Methyl-4,6-Dinitrophenol	500
Pentachlorophenol	350
4-Nitrophenol	90
<u>Chlorinated Herbicides</u>	
<u>SW Method 8150 (mg/kg dw)</u>	
Maximum Holding Times: 7 Days for Extraction 30 Days for Analysis	
2,4-D	0.03
2,4-DB	0.01
2,4,5-T	0.02
2,4,5-TP Silvex	0.003
DICAMBA	0.01
DICHLORPROP	0.05
DINOSEB	0.02
(4-Chloro-2-Methylphenoxy)-Acetic Acid	3.0
2-(4-Chloro-2-Methylphenoxy)-Propanoic Acid	11.0
Endothall	NA
<u>2,3,7,8-TCDD (Dioxin)</u>	
<u>SW Method 3550/8280 (ug/kg dw)</u>	
Maximum Holding Times: 7 Days for Extraction 30 Days for Analysis	
2,3,7,8-TCDD	1
<u>Petroleum Hydrocarbons</u>	
<u>SW Method 3550 and EPA Method 418.1 (mg/kg dw)</u>	
Maximum Holding Time: 28 Days	
Hydrocarbons by IR	1

TABLE I.2
SUMMARY OF CHEMICAL ANALYTICAL
METHODS, MAXIMUM HOLDING TIMES AND DETECTION LIMITS
FOR SOIL WATER SAMPLES
(Continued)

Analyte	Target Detection Limit
<u>Metals</u>	
<u>SW Methods 3050/7420, 7130, 7950, 7190 (mg/kg dw)</u>	
Maximum Detection Limit: 6 Months	
Lead (7420)	50
Cadmium (7130)	2.5
Chromium (7190)	25
Zinc (7950)	2.5
<u>Extractable Metals</u>	
<u>SW Methods 1310/6010 and 7471 (mg/L)</u>	
Maximum Holding Time: 6 Months	
*Arsenic	0.002
Barium	0.05
Cadmium	0.01
Chromium	0.05
*Lead	0.05
*Selenium	0.01
Silver	0.05
Mercury (7471) ²	0.0002

* To meet target detection limits, these metals were analyzed by graphite furnace AAS instead of ICPE: As (SW 7060), Se (SW 7740), Pb (SW 7421).

² Holding time for mercury analysis (7471) is 28 days.

TABLE I.3
SUMMARY OF HOLDING TIMES FOR
GROUND-WATER ANALYSES

Field Sample Identifier	Date Sample Collected	Purgeable Organics E601/602	R/N/A	Date Analyzed (Holding Time in Days)						Metals Scan E200.7/245.1
				Petroleum Hydrocarbons E418.1	Lead E219.2	Cadmium F213.2	Zinc F289.1	Chromium F218.2	FDR F502.1	
B MDB-1 GW ES	10-09-86	10-10-86(1) ^A	--	10-22-86(13)	10-22-86(13)	--	--	--	10-10-86(1)	--
B MDB-2 GW ES	10-09-86	10-10-86(1) ^A	--	10-22-86(13)	10-22-86(13)	--	--	--	10-10-86(1)	--
B MDB-3 GW ES	10-09-86	10-10-86(1) ^A	--	10-22-86(13)	10-22-86(13)	--	--	--	10-10-86(1)	--
B MDB-4 GW ES	10-09-86	10-10-86(1) ^A	--	10-22-86(13)	10-22-86(13)	--	--	--	10-10-86(1)	--
B MDB-5 GW	10-09-86	10-10-86(1) ^A	--	10-22-86(13)	10-22-86(13)	--	--	--	10-10-86(1)	--
DK MD3-1 GW ES	10-10-86	10-14-86(4) ^A	10-13(3) ^B / 10-24(11) ^C	--	--	--	--	--	--	10-86/11-86
DK MD3-2 GW ES	10-10-86	10-14-86(4) ^A	10-13(3) ^B / 10-24(11) ^C	--	--	--	--	--	--	10-86/11-86
DK MD3-3 GW FS	10-10-86	10-14-86(4) ^A	10-13(3) ^B / 10-24(11) ^C	--	--	--	--	--	--	10-86/11-86
DK MD3-6 GW ES	10-10-86	10-15-86(5) ^A	10-13(3) ^B / 10-24(11) ^C	--	--	--	--	--	--	10-86/11-86
DK MD3-7 GW	10-10-86	10-15-86(5) ^A	10-13(3) ^B / 10-24(11) ^C	--	--	--	--	--	--	10-86/11-86
PL MD58-1 GW ES	10-13-86	10-15-86(2)	10-14(1) ^B / 10-27(13) ^C	--	--	--	--	--	--	10-86/11-86
PL MD58-2 GW ES	10-13-86	10-15-86(2)	10-14(1) ^B / 10-27(13) ^C	--	--	--	--	--	--	10-86/11-86
PL MD58-3 GW FS	10-13-86	10-16-86(3)	10-14(1) ^B / 10-27(13) ^C	--	--	--	--	--	--	10-86/11-86
PL MD58-4 GW ES	10-13-86	10-15-86(2)	10-14(1) ^B / 10-27(13) ^C	--	--	--	--	--	--	10-86/11-86
PL MD58-5 GW ES	10-10-86	10-14-86(4) ^A	10-13(3) ^B / 10-24(11) ^C	--	--	--	--	--	--	10-86/11-86
PL MD58-6 GW FS	10-13-86	10-16-86(3)	10-14(1) ^B / 10-27(13) ^C	--	--	--	--	--	--	10-86/11-86
PL MD58-7 GW	10-13-86	10-15-86(2)	10-14(1) ^B / 10-27(13) ^C	--	--	--	--	--	--	10-86/11-86
RL MD9-2 GW ES	10-14-86	10-16-86(2)	10-15(1) ^B / 10-31(16) ^C	--	--	--	--	--	--	10-86/11-86
RL MD9-3 GW FS	10-17-86	10-19-86(2)	10-20(3) ^B / 11-8(19) ^C	--	--	--	--	--	--	10-86/11-86
RL MD9-4 GW ES	10-14-86	10-16-86(2)	10-15(1) ^B / 10-31(16) ^C	--	--	--	--	--	--	10-86/11-86
PL MD9-5 GW FS	10-14-86	10-16-86(2)	10-15(1) ^B / 11-4(20) ^C	--	--	--	--	--	--	10-86/11-86
RL MD9-6 GW ES	10-14-86	10-16-86(2)	10-15(1) ^B / 11-4(20) ^C	--	--	--	--	--	--	10-86/11-86
RL MD9-7 GW FS	10-14-86	10-16-86(2)	10-15(1) ^B / 11-4(20) ^C	--	--	--	--	--	--	10-86/11-86
PL MD9-8 GW	10-17-86	10-19-86(2)	10-20(3) ^B / 11-8(19) ^C	--	--	--	--	--	--	10-86/11-86
CP MD13-1 GW ES	10-17-86	--	10-20(3) ^B / 11-8(19) ^C	--	--	--	--	--	--	--
CP MD13-2 GW FS	10-17-86	--	10-20(3) ^B / 11-8(19) ^C	--	--	--	--	--	--	--
CP MD13-3 GW FS	10-17-86	--	10-20(3) ^B / 11-8(19) ^C	--	--	--	--	--	--	--

TABLE 1.1
SUMMARY OF HOLDING TIMES FOR
GROUND-WATER ANALYSES
(Continued)

Field Sample Identifier	Date Sample Collected	Purgeable Organics F601/602	R/N/A		Date Analyzed (Holding Time in Days)					Metals Scan E200.7/245.1
			Extractables E625	Petroleum Hydrocarbons E418.1	Lead F239.2	Cadmium F213.2	Zinc F289.1	Chromium F218.2	EDR F502.1	
DS MD17-1 GW ES	10-13-86	10-15-86(2)	10-14(1) ^B /10-28(14) ^C	--	10-86/11-86	10-86/11-86	10-86/11-86	--	--	--
DS MD17-2 GW ES	10-13-86	10-15-86(2)	10-14(1) ^B /10-28(14) ^C	--	10-86/11-86	10-86/11-86	10-86/11-86	--	--	--
DS MD17-3 GW ES	10-14-86	10-16-86(2)	10-15(1) ^B /11-7(23) ^C	--	10-86/11-86	10-86/11-86	10-86/11-86	--	--	--
DS MD17-4 GW	10-14-86	10-16-86(2)	10-15(1) ^B /11-7(23) ^C	--	10-86/11-86	10-86/11-86	10-86/11-86	--	--	--
FA MD23-1 GW ES	10-16-86	10-17-86(1)	--	10-23-86(7)	10-21-86(5)	--	--	--	--	--
FA MD23-2 GW ES	10-16-86	10-17-86(1)	--	10-23-86(7)	10-21-86(5)	--	--	--	--	--
FA MD23-3 GW ES	10-16-86	10-17-86(1)	--	10-23-86(7)	10-21-86(5)	--	--	--	--	--
FA MD23-4 GW ES	10-15-86	10-17-86(2)	--	10-22-86(7)	10-21-86(6)	--	--	--	--	--
FA MD23-5 GW ES	10-15-86	10-17-86(2)	--	10-22-86(7)	10-21-86(6)	--	--	--	--	--
FA MD23-6 GW ES	10-15-86	10-17-86(2)	--	10-22-86(7)	10-21-86(6)	--	--	--	--	--
FA MD23-7 GW ES	10-16-86	10-17-86(1)	--	10-23-86(7)	10-21-86(5)	--	--	--	--	--
FA MD23-8 GW ES	10-16-86	10-17-86(1)	--	10-23-86(7)	10-21-86(5)	--	--	--	--	--
FA MD23-9 GW ES	10-16-86	10-18-86(2)	--	10-23-86(6)	10-23-86(6)	--	--	--	--	--
FA MD23-10 GW ES	10-17-86	10-19-86(2)	--	10-23-86(7)	10-21-86(6)	--	--	--	--	--
FA MD23-11 GW ES	10-15-86	10-17-86(2)	--	10-22-86(7)	10-21-86(6)	--	--	--	--	--
FA MD23-12 GW ES	10-15-86	10-17-86(2)	--	10-22-86(7)	10-21-86(6)	--	--	--	--	--
FA MD23-13 GW ES	10-15-86	10-17-86(2)	--	10-22-86(7)	10-21-86(6)	--	--	--	--	--
FA MD23-14 GW ES	10-15-86	10-17-86(2)	--	10-22-86(7)	10-21-86(6)	--	--	--	--	--
FA MD23-15 GW	10-16-86	10-18-86(2)	--	10-23-86(7)	10-21-86(5)	--	--	--	--	--
FA MD23-D1 GW ES	10-17-86	10-19-86(2)	--	10-23-86(6)	10-23-86(6)	--	--	--	--	--
FA MD23-D2 GW ES	10-19-86	10-23-86(4)	--	10-23-86(4)	10-23-86(4)	--	--	--	--	--
FA MD23-D3 GW ES	10-17-86	10-19-86(4)	--	10-23-86(6)	10-23-86(6)	--	--	--	--	--
AO AP6-1 CW ES	10-29-86	10-31-86(2)	11-3(5) ^B /11-20(17) ^C	11-14-86(16)	--	--	--	--	--	11-86/12-86
AO AP6-2 CW ES	10-28-86	10-29-86(1)	10-30(2) ^B /11-19(20) ^C	11-13-86(16)	--	--	--	--	--	11-86/12-86
AO AP6-3 CW ES	10-28-86	10-31-86(3)	11-3(6) ^B /11-21(18) ^C	11-14-86(17)	--	--	--	--	--	11-86/12-86
AO AP6-4 W ES	10-28-86	10-29-86(1)	10-30(2) ^B /11-20(21) ^C	11-13-86(16)	--	--	--	--	--	11-86/12-86
AO AP6-5 W ES	10-28-86	10-31-86(3)	11-3(6) ^B /11-21(18) ^C	11-14-86(17)	--	--	--	--	--	11-86/12-86
AC AP7-1 GW ES	10-27-86	10-30-86(3)	10-30(3) ^B /11-20(21) ^C	11-13-86(17)	--	--	--	--	--	11-86/12-86
AC AP7-2 CW ES	10-27-86	10-29-86(2)	10-30(3) ^B /11-20(21) ^C	11-13-86(17)	--	--	--	--	--	11-86/12-86
AC AP7-3 GW ES	10-28-86	10-29-86(1)	10-30(2) ^B /11-20(21) ^C	11-13-86(17)	--	--	--	--	--	11-86/12-86
AC AP7-4 CW ES	10-28-86	10-29-86(1)	10-30(2) ^B /11-20(21) ^C	11-13-86(17)	--	--	--	--	--	11-86/12-86
AC AP7-5 GW ES	10-28-86	10-29-86(1)	10-30(2) ^B /11-20(21) ^C	11-13-86(17)	--	--	--	--	--	11-86/12-86

Notes: A GW G030/0030 performed instead of F602.

B Date extracted

C Date analyzed

TABLE I.4
SUMMARY OF HOLDING TIMES FOR
SURFACE WATER ANALYSES

Field Sample Identifier	Date Sample Collected	Purgeable Organics E601/602	R/N/A	Date Analyzed (Holding Time in Days)					Metals Scan E200.7/245.1	
				Extractables Organics F625	Petroleum Hydrocarbons F418.1	Lead F210.2	Cadmium E213.2	Zinc F289.1		Chromium F218.2
DK MD3-SW1 FS	10-19-86	10-22-86(3)	10-24(5) ^A /11-12(19) ^R	--	--	--	--	--	--	10-86/11-86
DK MD3-SW2 FS	10-19-86	10-23-86(4)	10-24(5) ^A /11-12(19) ^R	--	--	--	--	--	--	10-86/11-86
DK MD3-SW3 ES	10-19-86	10-22-86(3)	10-24(5) ^A /11-12(19) ^R	--	--	--	--	--	--	10-86/11-86
DK MD3-SW4 ES	10-19-86	10-23-86(4)	10-24(5) ^A /11-13(20) ^R	--	--	--	--	--	--	10-86/11-86
DK MD3-SW5 ES	10-19-86	10-23-86(3)	10-24(5) ^A /11-13(20) ^R	--	--	--	--	--	--	10-86/11-86
PL MD5R-SW1 FS	10-20-86	10-22-86(2)	10-23(3) ^A /11-12(20) ^R	--	--	--	--	--	--	10-86/11-86
PL MD5R-SW2 ES	10-20-86	10-22-86(2)	10-23(3) ^A /11-12(20) ^R	--	--	--	--	--	--	10-86/11-86
PL MD5R-SW3 ES	10-20-86	10-22-86(2)	10-23(3) ^A /11-12(20) ^R	--	--	--	--	--	--	10-86/11-86
PL MD5R-SW4 ES	10-20-86	10-22-86(2)	10-23(3) ^A /11-12(20) ^R	--	--	--	--	--	--	10-86/11-86
PL MD5R-SW5 ES	10-20-86	10-22-86(2)	10-23(3) ^A /11-12(20) ^R	--	--	--	--	--	--	10-86/11-86
RL MD9-SW1 ES	10-20-86	10-23-86(3)	10-23(3) ^A /11-12(20) ^R	--	--	--	--	--	--	10-86/11-86
RL MD9-SW2 ES	10-20-86	10-23-86(2)	10-23(3) ^A /11-12(20) ^R	--	--	--	--	--	--	10-86/11-86
CM MD11-SW1 ES	10-21-86	10-23(2)	10-22(1) ^A /11-17(26) ^R	--	--	--	--	--	--	11-86/12-86
CM MD11-SW2 ES	10-21-86	10-23(2)	10-22(1) ^A /11-17(26) ^R	--	--	--	--	--	--	11-86/12-86
CM MD11-SW3 ES	10-21-86	10-23(2)	10-22(1) ^A /11-17(26) ^R	--	--	--	--	--	--	11-86/12-86
FT MD16-SW1 ES	10-21-86	10-23(2) ^C	--	11-13-86(23)	11-12-86(22)	--	--	--	10-22(1) ^A /11-17(26) ^R	--
FT MD16-SW2 ES	10-21-86	10-23(2) ^C	--	11-13-86(23)	11-12-86(22)	--	--	--	10-22(1) ^A /11-17(26) ^R	--
FT MD16-SW3 ES	10-21-86	10-23(2) ^C	--	11-13-86(23)	11-12-86(22)	--	--	--	10-22(1) ^A /11-17(26) ^R	--
FT MD16-SW4 ES	10-21-86	10-23(2) ^C	--	11-13-86(23)	11-12-86(22)	--	--	--	10-22(1) ^A /11-17(26) ^R	--
FT MD16-SW5 ES	10-21-86	10-23(2) ^C	--	11-13-86(23)	11-12-86(22)	--	--	--	10-22(1) ^A /11-17(26) ^R	--
FT MD16-SW6 ES	10-21-86	10-23(2) ^C	--	11-13-86(23)	11-12-86(22)	--	--	--	10-22(1) ^A /11-17(26) ^R	--

TABLE I.4
SUMMARY OF HOLDING TIMES FOR
CURENCE WATER ANALYSES

Field Sample Identifier	Date Sample Collected	Purgeable Organics E601/602	R/N/A Extractables Organics E625	Petroleum Hydrocarbons E418.1	Date Analyzed (Holding Time in Days)					Metals Scan E200.7/245.1
					Lead E230.2	Cadmium E213.2	Zinc E209.1	Chromium E218.2	EDR E502.1	
DS MD17-SW3 ES	10-20-86	10-23-86(3)	10-24(4) ^A /11-11(18) ^B	--	10-86/11-86	10-86/11-86	10-86/11-86	10-86/11-86	--	--
AO AP6-SW1 ES	10-30-86	10-31-86(1)	11-3(4) ^A /11-21(18) ^B	11-14-86(15)	--	--	--	--	--	11-14-86(15)
AO AP6-SW2 ES	10-29-86	10-31-86(2)	11-3(5) ^A /11-21(19) ^B	11-14-86(16)	--	--	--	--	--	11-14-86(16)
AO AP6-SW3 ES	10-29-86	10-31-86(2)	11-3(5) ^A /11-21(19) ^B	11-14-86(16)	--	--	--	--	--	11-14-86(16)

Notes: A - Date Extracted

B - Date Analyzed

C - SW Method 5030/8020 run instead of Method 602.

TABLE I.5
SUMMARY OF HOLDING TIMES FOR
SEDIMENT SAMPLE ANALYSES

Field Sample Identifier	Date Sample Collected	Purgeable Organics E601/602	R/N/A		Petroleum Hydrocarbons E418.1	Lead E219.2	Cadmium E213.2	Zinc E289.1	Chromium E218.2	FDR E502.1	Metals Scan E200.7/245.1
			Extractables E625	Organics E625							
DK MD3-SD1 ES	10-19-86	10-27-86(R)	10-29(10) ^A /11-15(17) ^R		--	--	--	--	--	--	10-86/11-86
DK MD3-SD2 ES	10-19-86	10-27-86(R)	10-27(8) ^A /11-15(19) ^R		--	--	--	--	--	--	10-86/11-86
DK MD3-SD3 ES	10-19-86	10-27-86(R)	10-27(8) ^A /11-15(19) ^R		--	--	--	--	--	--	10-86/11-86
DK MD3-SD4 ES	10-19-86	10-27-86(R)	10-29(10) ^A /11-15(17) ^R		--	--	--	--	--	--	10-86/11-86
DK MD3-SD5 ES	10-19-86	10-26-86(7)	10-27(8) ^A /11-15(19) ^R		--	--	--	--	--	--	10-86/11-86
DK MD3-SD6 ES	10-20-86	10-26-86(6)	10-27(7) ^A /11-15(19) ^R		--	--	--	--	--	--	10-86/11-86
DK MD3-SD7 ES	10-20-86	10-27-86(7)	10-28(8) ^A /11-16(19) ^R		--	--	--	--	--	--	10-86/11-86
DK MD3-SD8	10-19-86	10-26-86(7)	10-27(8) ^A /11-16(20) ^R		--	--	--	--	--	--	10-86/11-86
PL MD58-SD1 ES	10-20-86	10-27-86(7)	10-27(7) ^A /11-17(21) ^R		--	--	--	--	--	--	10-86/11-86
PL MD58-SD2 ES	10-20-86	10-27-86(7)	10-27(7) ^A /11-17(21) ^R		--	--	--	--	--	--	10-86/11-86
PL MD58-SD3 ES	10-20-86	10-26-86(6)	10-27(7) ^A /11-14(18) ^R		--	--	--	--	--	--	10-86/11-86
PL MD58-SD4 ES	10-20-86	10-26-86(6)	10-28(8) ^A /11-14(17) ^R		--	--	--	--	--	--	10-86/11-86
PL MD58-SD5 ES	10-20-86	10-26-86(6)	10-28(8) ^A /11-14(17) ^R		--	--	--	--	--	--	10-86/11-86
PL MD9-SD1 ES	10-20-86	10-27-86(7)	10-27(7) ^A /11-16(20) ^R		--	--	--	--	--	--	10-86/11-86
RL MD9-SD2 ES	10-20-86	10-27-86(7)	10-27(7) ^A /11-16(20) ^R		--	--	--	--	--	--	10-86/11-86
CM MD11-SD1 ES	10-21-86	11-03(13)	10-27(6) ^A /11-17(21) ^R		--	--	--	--	--	--	11-86/12-86
CM MD11-SD2 ES	10-21-86	11-01(11)	10-27(6) ^A /11-17(21) ^R		--	--	--	--	--	--	11-86/12-86
CM MD11-SD3 ES	10-21-86	11-03(13)	10-27(6) ^A /11-18(22) ^R		--	--	--	--	--	--	11-86/12-86
FT MD16-SD1 ES	10-21-86	11-03(13) ^C		11-14-86(24)	11-12-86(22)	--	--	--	--	--	--
FT MD16-SD2 ES	10-21-86	11-03(13) ^C		11-14-86(24)	11-12-86(22)	--	--	--	--	--	--
FT MD16-SD3 ES	10-21-86	11-01(11) ^C		11-14-86(24)	11-12-86(22)	--	--	--	--	--	--
FT MD16-SD4 ES	10-21-86	11-03(13) ^C		11-14-86(24)	11-12-86(22)	--	--	--	--	--	--
FT MD16-SD5 ES	10-21-86	11-03(13) ^C		11-14-86(24)	11-12-86(22)	--	--	--	--	--	--
FT MD16-SD6 ES	10-21-86	11-03(13) ^C		11-14-86(24)	11-12-86(22)	--	--	--	--	--	--

TABLE 1.5
SUMMARY OF HOLDING TIMES FOR
SEDIMENT SAMPLE WATER ANALYSES
(Continued)

Field Sample Identifier	Date Sample Collected	Purgeable Organics E601/602	B/N/A Extractables Organics E625	Petroleum Hydrocarbons E418.1	Date Analyzed (Holding Time in Days)					Metals Scan E200.7/245.1
					Lead E219.2	Cadmium E213.2	Zinc E289.1	Chromium E218.2	EDR E502.1	
DS MD17-SD1 ES	10-20-86	10-26-86(6)	10-28(8) ^A /11-14(17) ^B	--	11-86/12-86	11-86/12-86	11-86/12-86	11-86/12-86	--	--
DS MD17-SD2 ES	10-20-86	10-27-86(7)	10-28(8) ^A /11-16(19) ^B	--	11-86/12-86	11-86/12-86	11-86/12-86	11-86/12-86	--	--
DS MD17-SD3 ES	10-20-86	10-26-86(6)	10-28(8) ^A /11-14(17) ^B	--	11-86/12-86	11-86/12-86	11-86/12-86	11-86/12-86	--	--
DS MD17-SD4	10-20-86	11-01-86(11)	10-27(6) ^A /11-18(28) ^B	--	11-86/12-86	11-86/12-86	11-86/12-86	11-86/12-86	--	--
AO AP6-SD1 ES	10-30-86	11-05-86(6)	11-5(6) ^A /11-22(17) ^B	--	--	--	--	--	--	11-14-86(15)
AO AP6-SD2 ES	10-29-86	11-05-86(7)	11-5(7) ^A /11-22(17) ^B	--	--	--	--	--	--	11-14-86(16)
AO AP6-SD3 ES	10-29-86	11-05-86(7)	11-5(7) ^A /11-22(17) ^B	--	--	--	--	--	--	11-14-86(16)
AO AP6-SD4 ES	10-29-86	11-05-86(7)	11-5(7) ^A /11-22(17) ^B	--	--	--	--	--	--	11-14-86(16)

Notes: A - Date Extracted
B - Date Analyzed

TABLE I.6
SUMMARY OF HOLDING TIMES FOR
SOIL SAMPLE ANALYSES

Field Sample Identifier	Date Collected	Date Analyzed (Holding Time in Days)	
		Dioxins SW 3550/8280	Herbicides SW 8150
AA AP9 SS1 ES	10-29-86	11-5-86(7)	11-4-86(6) ^a /11--22-86(18) ^b
AA AP9 SS2 ES	10-29-86	11-5-86(7)	11-4-86(6) ^a /11--22-86(18) ^b
AA AP9 SS3 ES	10-29-86	11-5-86(7)	11-4-86(6) ^a /11--22-86(18) ^b
AA AP9 SS4 ES	10-29-86	11-5-86(7)	11-4-86(6) ^a /11--22-86(18) ^b
AA AP9 SS5 ES	10-29-86	11-5-86(7)	11-4-86(6) ^a /11--22-86(18) ^b
AA AP9 SS6 ES	10-29-86	11-5-86(7)	11-4-86(6) ^a /11--22-86(18) ^b
AA AP9 SS7 ES	10-29-86	11-5-86(7)	11-4-86(6) ^a /11--22-86(18) ^b
AA AP9 SS8 ES	10-29-86	11-5-86(7)	11-4-86(6) ^a /11--22-86(18) ^b
AA AP9 SS9 ES	10-29-86	11-5-86(7)	11-4-86(6) ^a /11--22-86(18) ^b
AA AP9 SS10 ES	10-29-86	11-5-86(7)	11-4-86(6) ^a /11--22-86(18) ^b
AA AP9 SS11 ES	10-29-86	11-5-86(7)	11-4-86(6) ^a /11--22-86(18) ^b

a - Date extracted

b - Date analyzed

TABLE 1.7
SUMMARY OF QUALITY ASSURANCE RESULTS
MISCELLANEOUS PARAMETERS MEASURED IN GROUNDWATER

Blind Duplicate Field Samples		Analytical Results		
Sample 1	Sample 2	Sample 1	Sample 2	Relative Difference
<u>Purgeable Halocarbons ug/L (E601)</u>				
R MDR-4 GW FS	R MDR-5 GW	ND	ND	--
DF MD3-1 GW FS	DF MD3-7 GW	ND	ND	--
PL MD5R-4 GW FS	PL MD5R-7 GW	Chlorobenzene-ND	Chlorobenzene-ND	--
		1,4-Dichlorobenzene-2.1	1,4-Dichlorobenzene-2.3	9.1
PL MD9-3 GW FS	PL MD9-8 GW	1,1-Dichloroethane-1.3	1,1-Dichloroethane-1.4	7.1
DS MD17-3 GW FS	DS MD17-4 GW	ND	ND	--
FA MD23-7 GW FS	FA MD23-16 GW	ND	ND	--
AC AP7-4 GW FS	AC AP7-5 GW FS	ND	ND	--
Field Blank	AO AP6-5 GW FS	--	ND	--
<u>Aromatic Volatile Organics ug/L (GW 5030/8020)</u>				
R MDR-4 GW FS	R MDR-5 GW	ND	ND	--
DF MD3-1 GW FS	DF MD3-7 GW	ND	ND	--
<u>Purgeable Aromatics ug/L (E602)</u>				
PL MD5R-4 GW FS	PL MD5R-7 GW	Benzene-31 ^b	Benzene-45	31
--	--	Chlorobenzene-5.3	Chlorobenzene-ND ^b	--
PL MD9-3 GW FS	PL MD9-8 GW	1,4-Dichlorobenzene-11	1,4-Dichlorobenzene-12	8.3
DS MD17-3 GW FS	DS MD17-4 GW	Benzene-2.4	Benzene-ND	--
FA MD23-7 GW FS	FA MD23-16 GW	ND	ND	--
AC AP7-4 GW FS	AC AP7-5 GW FS	ND	ND	--
Field Blank	AO AP6-5 GW FS	--	ND	--
<u>1,2-Dibromomethane ug/L (E602.1)</u>				
P MDR-4 GW FS	R MDR-5 GW	ND	ND	--
<u>Base/Neutral and Acid Extractable Organics ug/L (E625)</u>				
DF MD3-1 GW FS	DF MD3-7 GW	Bis(2-Ethylhexyl)phthalate-250	Bis(2-Ethylhexyl)phthalate-240	4.1
PL MD5R-4 GW FS	PL MD5R-7 GW	Di-N-Butyl Phthalate-ND	Di-N-Butyl Phthalate-34	--
		Bis(2-Ethylhexyl)phthalate-200	Bis(2-Ethylhexyl)phthalate-170	16
PL MD9-3 GW FS	PL MD9-8 GW	Di-N-Butyl Phthalate-18	Di-N-Butyl Phthalate-16	12
DS MD17-3 GW FS	DS MD17-4 GW	ND	ND	--
AC AP7-4 GW FS	AC AP7-5 GW FS	Bis(2-Ethylhexyl)phthalate-37	Bis(2-Ethylhexyl)phthalate-36	34
Field Blank	AO AP6-5 GW FS	Di-N-Butyl Phthalate-15	Di-N-Butyl Phthalate-12	21
		--	ND	--

TABLE 1.7
SUMMARY OF QUALITY ASSURANCE RESULTS
MISCELLANEOUS PARAMETERS MEASURED IN GROUNDWATER
(Continued)

Blind Duplicate Field Samples		Analytical Results		
Sample 1	Sample 2	Sample 1	Sample 2	Relative % Difference
Petroleum Hydrocarbons mg/L (E418)				
R MDR-4 GW ES	R MDR-5 GW	0.50	ND	--
FA MD23-7 GW ES	FA MD23-16 GW	ND	ND	--
AC AP7-4 GW ES	AC AP7-5 GW ES	ND	ND	--
Field Blank	AO AP6-5 GW ES	--	ND	--
Metals Scan mg/L (E200.7 and E245.1)^c				
DK MD3-1 GW ES	DK MD3-7 GW	Aluminum - 6.7	Aluminum-6.7	0
		Arsenic-0.01 ^a	Arsenic-0.01 ^a	0
		Barium-0.18	Barium-0.20	10
		Boron-0.90	Boron-1.1	20
		Calcium-580	Calcium-580	0
		Iron-6.6	Iron-6.4	3.1
		Lead-0.01 ^a	Lead-0.03 ^a	100
		Magnesium-430	Magnesium-520	19
		Manganese-0.08	Manganese-0.09	11
		Molybdenum-0.01	Molybdenum-ND	--
		Potassium-120	Potassium-140	15
		Selenium-0.39 ^a	Selenium-0.46 ^a	16
		Silica-24	Silica-17	33
		Sodium-3600	Sodium-4300	18
PL MDR-4 GW ES	PL MDR-7 GW	Aluminum-3.0	Aluminum-ND	--
		Barium-0.08	Barium-0.08	0
		Boron-1.1	Boron-1.1	0
		Calcium-100	Calcium-100	0
		Iron-14	Iron-17	19
		Magnesium-27	Magnesium-26	3.7
		Potassium-38	Potassium-38	0
		Silica-18	Silica-18	0
		Sodium-65	Sodium-62	4.7
PL MDR-3 GW ES	PL MDR-8 GW	Aluminum-19	Aluminum-18	5.3
		Arsenic-0.02 ^a	Arsenic-0.02 ^a	0
		Boron-1.3	Boron-1.3	0
		Calcium-150	Calcium-150	0
		Iron-4.5	Iron-4.8	6.4
		Lead-0.01	Lead-0.01	0
		Magnesium-160	Magnesium-170	6.1
		Manganese-0.06	Manganese-0.06	0
		Potassium-110	Potassium-110	0

TABLE 1.2
SUMMARY OF QUALITY ASSURANCE RESULTS
MISCELLANEOUS PARAMETERS MEASURED IN GROUNDWATER
(continued)

Blind Duplicate Field Samples		Analytical Results		
Sample 1	Sample 2	Sample 1	Sample 2	Relative % Difference
RL MD9-3 GW ES	RL MD9-8 GW	Selenium-0.18 ^a Silica-34 Sodium-2400 Vanadium-0.08	Selenium-0.20 ^a Silica-35 Sodium-2500 Vanadium-0.09	11 35 2450 11
AC AP7-4 GW ES	AC AP7-5 GW ES	Aluminum-7.6 Barium-0.13 Calcium-45 Copper-0.08 Iron-15 Lead-0.01 Magnesium-14 Potassium-1.5 Selenium-0.01 Silica-75 Sodium-28 Vanadium-0.09 Manganese-ND Nickel-ND	Aluminum-11 Barium-0.18 Calcium-56 Iron-18 Lead-0.02 ^a Magnesium-17 Potassium-1.8 Selenium-0.01 Silica-85 Sodium-28 Vanadium-0.12 Manganese-0.05 Nickel-0.05	37 31 22 18 -- 19 18 ND 13 0 27 -- --
Field Blank	AO AP6-5 GW ES	-- --	Calcium-0.26 Silica-0.60	-- --
Lead mg/L (E239.2)				
R MDR-4 GW ES	R MDR-5 GW	ND	ND	--
DS MD17-3 GW ES	DS MD17-4 GW	ND	ND	--
FA MD23-7 GW ES	FA MD23-16 GW	ND	ND	--
Cadmium mg/L (E211.2)				
DS MD17-3 GW ES	DS MD17-4 GW	ND	ND	--
Chromium mg/L (E218.2)				
DS MD17-3 GW ES	DS MD17-4 GW	ND	ND	--
Zinc mg/L (E289.1)				
DS MD17-3 GW ES	DS MD17-4 GW	ND	ND	--

ND = No compound detected above detection limit.
a = The high salinity content of the sample was suspected of causing a positive interference during analysis of the metals indicated.
b = Chromatograph contained many hydrocarbon peaks which made identification difficult.
c = To meet the target detection limit, five metals were analyzed by graphite furnace AAS instead of 14. Pb, As (E200.2), Sb (E204.2), Cd (E201.2), Hg (E203.2), Mo (E206.2).

TABLE I.B
SUMMARY OF QUALITY ASSURANCE RESULTS
MISCELLANEOUS PARAMETERS MEASURED IN SEDIMENT AND SOIL SAMPLES

Blind Duplicate Field Samples		Analytical Results			Relative % Difference
Sample 1	Sample 2	Sample 1	Sample 2	Average	
<u>Volatile Organics mg/kg dw (SW 5030/R240)</u>					
DK MD3-SD5 ES	DK MD3-SDR	ND	ND	--	--
DS MD17-SD1 ES	DS MD17-SD4	ND	ND	--	--
AO AP6-SD3 ES	AO AP6-SD4 ES	ND	ND	--	--
<u>Semivolatiles Organics mg/kg dw (SW 3550/R270)</u>					
DK MD3-SD5 ES	DK MD3-SDR	ND	ND	--	--
DS MD17-SD1 ES	DS MD17-SD4	Pyrene-ND	Pyrene-0.5R	--	--
AO AP6-SD3 ES	AO AP6-SD4 ES	Bis(2-ethylhexyl)phthalate - ND	Bis(2-ethylhexyl)phthalate-0.6R	--	--
<u>Petroleum Hydrocarbons mg/kg dw (SW 3550/F.418.1)</u>					
AO AP6-SD3 ES	AO AP6-SD4 ES	ND	ND	--	--
<u>Lead mg/kg dw (SW 3050/7420)</u>					
DS MD17-SD1 ES	DS MD17-SD4	30	46	38	47
<u>EP Toxicity - including Mercury - mg/L (SW 1310/6010^a and 7471)</u>					
DK MD3-SD5 ES	DK MD3-SDR	ND	ND	--	--
AO AP6-SD3 ES	AO AP6-SD4 ES	ND	ND	--	--
<u>Cadmium mg/kg dw (SW 3050/7130)</u>					
DS MD17-SD1 ES	DS MD17-SD4	ND	0.31	--	--
<u>Chromium mg/kg dw (SW 3050/7190)</u>					
DS MD17-SD1 ES	DS MD17-SD4	4.3	11	7.7	87
<u>Zinc mg/kg dw (SW 3050/7950)</u>					
DS MD17-SD1 ES	DS MD17-SD4	5.5	33	19.3	142
<u>Chlorinated Herbicides mg/kg dw (SW 8150)</u>					
AA AP9 - SSR ES	AA AP9-SS11 ES	ND	ND	--	--
<u>Dioxin ug/kg (SW 3550/R280)</u>					
AA AP9-SSR ES	AA AP9-SS11 ES	ND	ND	--	--

ND - No compound detected above detection limit.

a - To meet the target detection limits, three samples were analyzed by graphite furnace AAS instead of using a cold vapor method, Pb (SW7421).

TABLE I.9
SUMMARY OF QUALITY CONTROL RESULTS
WATER SAMPLES

Compound	Number of Duplicates	Relative % Difference			Number of Spikes	Spike Concentration (ug/L)	Percent Recovery		
		Low	Average	High			Low	Average	High
EPA Method 601									
Bromodichloromethane	11	--	ND	--	8	10	68	84	123
Bromoform	11	--	ND	--	8	10	63	108	143
Bromethane	11	--	ND	--	3	10	94	122	169
Carbon tetrachloride	11	--	ND	--	--	--	--	--	--
Chlorobenzene	11	--	ND	--	--	--	--	--	--
Chloroethane	11	--	ND	--	3	10	97	104	116
2-Chloroethylvinyl ether	11	--	ND	--	--	--	--	--	--
Chloroform	11	--	ND	--	--	--	--	--	--
Chloromethane	11	--	ND	--	3	10	99	109	121
Dibromochloromethane	11	--	ND	--	--	--	--	--	--
1,2-Dichlorobenzene	11	--	ND	--	--	--	--	--	--
1,3-Dichlorobenzene	11	--	ND	--	--	--	--	--	--
1,4-Dichlorobenzene	11	--	ND	--	--	--	--	--	--
Dichlorodifluoromethane	11	--	ND	--	--	--	--	--	--
1,1-Dichloroethane	11	--	ND	--	--	--	--	--	--
1,2-Dichloroethane	11	--	ND	--	--	--	--	--	--
1,1-Dichloroethene	11	--	ND	--	--	--	--	--	--
Trans-1,2-dichloroethene	11	--	ND	--	8	10	54	81	115
1,2-Dichloropropane	11	--	ND	--	--	--	--	--	--
Cis-1,3-dichloropropene	11	--	ND	--	--	--	--	--	--
Trans-1,3-dichloropropene	11	--	ND	--	8	10	61	84	144
Methylene chloride	11	--	ND	--	--	--	--	--	--
1,1,2,2-Tetrachloroethane	11	--	ND	--	8	10	39	97	193
Tetrachloroethene	11	--	ND	--	--	--	--	--	--
1,1,1-Trichloroethane	11	--	ND	--	8	10	76	105	143
1,1,2-Trichloroethane	11	--	ND	--	--	--	--	--	--
Trichloroethene	11	--	ND	--	--	--	--	--	--
Trichlorofluoromethane	11	--	ND	--	--	--	--	--	--
Vinyl chloride	11	--	ND	--	3	10	95	98	100
EPA Method 602									
Benzene	11	--	ND	--	8	10	98	106	118
Chlorobenzene	11	--	ND	--	--	--	--	--	--
1,2-Dichlorobenzene	11	--	ND	--	--	--	--	--	--
1,3-Dichlorobenzene	11	--	ND	--	--	--	--	--	--
1,4-Dichlorobenzene	11	--	ND	--	--	--	--	--	--
Ethylbenzene	11	--	ND	--	8	10	90	104	118
Toluene	11	--	ND	--	8	10	93	103	116

TABLE I.9
SUMMARY OF QUALITY CONTROL RESULTS
WATER SAMPLES
(Continued)

Compound	Number of Duplicates	Relative % Difference			Number of Spikes	Spike Concentration (ug/L)	Percent Recovery		
		Low	Average	High			Low	Average	High
<u>Methods E625 and SW3550/8270</u>									
1,2,4-Trichlorobenzene	b	--	--	--	8	100 ug	13	72	111
Acenaphthene	b	--	--	--	8	100 ug	64	73	85
2,4-Dinitrotoluene	b	--	--	--	8	100 ug	59	85	131
Pyrene	b	--	--	--	8	100 ug	58	83	115
N-Nitrosodi-n-propylamine	b	--	--	--	8	100 ug	98	73	45
1,4-Dichlorobenzene	b	--	--	--	4	100 ug	53	60	65
Pentachlorophenol	b	--	--	--	8	200 ug	24	57	83
Phenol	b	--	--	--	4	200 ug	30	59	87
2-Chlorophenol	b	--	--	--	4	200 ug	14	53	117
4-Chloro-3-methylphenol	b	--	--	--	8	200 ug	30	50	118
4-Nitrophenol	b	--	--	--	6	200 ug	15	34	49
<u>EPA Method 418.1</u>									
Petroleum Hydrocarbon	4	--	ND	--	4	1	76	91	104
<u>EPA Method 502.1</u>									
1,2-Dibromoethane	2	--	ND	--	2	0.1	90	100	110
<u>EPA Methods 239.2</u>									
Lead	4 (3-ND)	--	0	--	4	0.1 (one 0.05 mg/L)	100	110	120
<u>EPA Method 213.2</u>									
Cadmium	1	--	ND	--	1	0.05	--	94	--
<u>EPA Method 218.2</u>									
Chromium	1	--	ND	--	1	0.05	--	92	--
<u>EPA Method 289.1</u>									
Zinc	1	--	ND	--	1	0.5	--	104	--
<u>EPA Method 245.1</u>									
Mercury	2	--	ND	--	2	0.001	--	100	--

TABLE I.9
SUMMARY OF QUALITY CONTROL RESULTS
WATER SAMPLES
(Continued)

Compound	Number of Duplicates	Relative % Difference			Number of Spikes	Spike Concentration (mg/L)	Percent Recovery		
		Low	Average	High			Low	Average	High
EPA Methods 200.7 ^a and 245.1									
Aluminum	2	--	0	--	2	10.0	92	--	95
Antimony	2	--	ND	--	2	0.1	--	80	--
Arsenic	2	ND	--	50	2	0.1	81	--	90
Barium	2	--	0	--	2	1.0	91	--	97
Beryllium	2	--	ND	--	2	0.1	100	--	110
Boron	2	0	--	18	2	1.0	80	--	120
Cadmium	2	--	ND	--	2	0.1	80	--	90
Calcium	2	0	--	7	2	100.0	110	--	120
Chromium	2	--	ND	--	2	0.5	84	--	94
Copper	2	--	ND	--	2	0.5	--	98	--
Iron	2	0	--	13	2	10.0	90	--	120
Lead	2	--	ND	--	2	0.1	80	--	90
Magnesium	2	0	--	7.4	2	1.0	92	--	93
Manganese	2	ND	--	0	2	1.0	--	110	--
Molybdenum	2	--	ND	--	2	0.1	100	--	110
Nickel	2	--	ND	--	2	1.0	97	--	120
Potassium	2	8	--	17	2	10.0	--	110	--
Selenium	2	ND	--	67	2	0.1	80	--	90
Silica	2	--	0	--	2	10.0	80	--	100
Silver	2	--	ND	--	2	0.1	90	--	100
Sodium	2	0	--	9	2	10-1000	80	--	90
Thallium	2	--	ND	--	2	1.0	--	110	--
Vanadium	2	--	ND	--	2	1.0	--	100	--
Zinc	2	--	ND	--	2	1.0	--	105	--
Mercury (245.1)	2	--	ND	--	2	0.001	--	100	--

ND - No compound detected above detection limit.

a - To meet the target detection limits, five metals were analyzed by graphite furnace AAS instead of ICPE: As(E206.2), Sb(E204.2), Se(E270.2), Pb(E239.2), Mo(E246.2).

b - Matrix spike duplicates were run in accordance with CLP protocol and results were within CLP precision guidelines.

TABLE I.10
SUMMARY OF QUALITY CONTROL RESULTS
SEDIMENT AND SOIL SAMPLES

Compound	Number of Duplicates	Relative % Difference			Number of Spikes	Spike Concentration (ug/L)	Percent Recovery		
		Low	Average	High			Low	Average	High
<u>SW Method 5030/8240</u>									
1,1-Dichloroethene	b	--	--	--	2	50 ug	--	79	--
Trichloroethene	b	--	--	--	2	50 ug	--	115	--
Chlorobenzene	b	--	--	--	2	50 ug	--	84	--
Toluene	b	--	--	--	2	50 ug	--	78	--
Benzene	b	--	--	--	2	50 ug	--	83	--
<u>SW Method 3550/8280</u>									
Dioxin	1	--	11.5	--	3	5 ug/Kg	82	90	96
<u>SW Method 8150</u>									
2,4-D	1	--	ND	--	2	0.2 ug/kg	105	--	106
2,4-DB	1	--	ND	--	1	0.2 ug/kg	--	95	--
2,4,5-T	1	--	ND	--	1	0.2 ug/kg	--	85	--
2,4,5-TP Silvex	1	--	ND	--	1	0.2 ug/kg	84	--	85
DICAMBRA	1	--	ND	--	1	0.2 ug/kg	--	80	--
DICHLORPROP	1	--	ND	--	1	0.5 ug/kg	--	86	--
DINOSE B	1	--	ND	--	1	0.2 ug/kg	--	105	--
(4-Chloro-2-methylphenoxy) - acetic acid	1	--	ND	--	1	50 ug/kg	--	74	--
2-(4-Chloro-2-methylphenoxy) - propanoic acid	1	--	ND	--	1	50 ug/kg	--	82	--
<u>Methods SW3550 and F418.1</u>									
Petroleum Hydrocarbon	1	--	ND	--	1	1.0 ug/g	--	80	-

TABLE I.10 (Continued)
SUMMARY OF QUALITY CONTROL RESULTS
SEDIMENT AND SOIL SAMPLES

Compound	Number of Duplicates	Relative % Difference			Number of Spikes	Spike Concentration (ug/L)	Percent Recovery		
		Low	Average	High			Low	Average	High
<u>SW Method 3050/7420</u>									
Lead	1	--	0	--	1	0.05 ug/g	--	120	--
<u>SW Methods 1310/6010^a and 7471</u>									
Arsenic	2	--	ND	--	2	0.1 mg/L	--	80	--
Barium	2	--	ND	--	2	0.5 mg/L	98	--	106
Cadmium	2	--	ND	--	2	0.1 mg/L	90	--	100
Chromium	2	--	ND	--	2	0.5 mg/L	86	--	98
Lead	2	--	ND	--	2	0.5 mg/L	98	--	104
Selenium	2	--	ND	--	2	0.1 mg/L	100	--	110
Silver	2	--	ND	--	2	0.1 mg/L	80	--	90
Mercury	1	--	ND	--	2	0.001 mg/L	80	--	100
<u>SW Methods 3050/7420, 7130, 7190, 7950</u>									
Lead	1	--	8	--	1	8.2 ug/g	--	73	--
Cadmium	1	--	0	--	1	2.0 ug/g	--	101	--
Chromium	1	--	4	--	1	2.2 ug/g	--	101	0
Zinc	1	--	20	--	1	8.2 ug/g	--	124	--

ND - No compound detected above detection limit.

a - To meet the target detection limits, three metals were analyzed by graphite furnace AAS instead of ICPES: As(SW7060), Se(SW7740), Pb(SW7421).

b - Matrix spike duplicates were run in accordance with CLP protocol and results were within CLP precision guidelines.

QA/QC DATA SHEETS
AUGUST 1987 SAMPLING

TABLE I.11
SUMMARY OF HOLDING TIMES FOR GROUND-WATER ANALYSES
FOR AUGUST 1987 SAMPLES

Field Sample Identifier	Date Sample Collected	Date Analyzed (Holding Time in Days)			
		Purgeable Organics E601/602 (8010/8020)	B/N/A Extractables Organics E625	Petroleum Hydrocarbons E418.1	Lead E239.1
MDB-1 GW ES	8-14-87	8-28-87 ^C (14)	--	8-29-87 ^b (1) 9-2-87 ^C (5) 8-29-87 ^b (1)	8-25-87 ^C (11)
MDB-2-GW ES	8-14-87	8-28-87 ^C (14)	--	9-2-87 ^C (5) 8-29-87 ^b (1)	8-25-87 ^C (11)
MDB-3 GW ES	8-14-87	8-28-87 ^C (14)	--	9-2-87 ^C (5) 8-29-87 ^b (1)	8-25-87 ^C (11)
MDB-4 GW ES	8-14-87	8-28-87 ^C (14)	--	9-2-87 ^C (5)	8-25-87 ^C (11)
MDB-5 GW ES	8-12-87	--	8-14-87 ^b (2) 9-14-87 ^C (31)	--	--
MDB-6 GW ES	8-14-87	8-28-87 ^C (14)	--	8-29-87 ^b (1) 9-2-87 ^C (5)	8-25-87 ^C (11)

MD3-1 GW ES	8-12-87	--	9-14-87 ^b (2) 9-14-87 ^C (31)	--	--
MD3-2 GW ES	8-11-87	--	--	--	--
MD3-3 GW ES	8-11-87	--	--	--	--
MD3-6 GW ES	8-11-87	--	--	--	--

TABLE I.11 (Continued)
SUMMARY OF HOLDING TIMES FOR GROUND-WATER ANALYSES
FOR AUGUST 1987 SAMPLES

Field Sample Identifier	Date Sample Collected	Purgeable Organics E601/602 (8010/8020)	Date Analyzed (Holding Time in Days)			
			B/N/A Extractables Organics E625	Petroleum Hydrocarbons E418.1	Lead E239.1	
MD58-1 GW ES	8-13-87	8-26-87 ^c (13)	8-18-87 ^b (5) 9-24-87 ^c (37)	--	--	
MD58-2 GW ES	8-13-87	8-26-87 ^c (13)	8-18-87 ^b (5) 9-24-87 ^c (37)	--	--	
MD58-3 GW ES	8-13-87	8-26-87 ^c (13)	8-18-87 ^b (5) 9-24-87 ^c (37)	--	--	
MD58-4 GW ES	8-13-87	8-26-87 ^c (13)	8-17-87 ^b (4) 9-24-87 ^c (37)	--	--	
MD58-5 GW ES	8-13-87	8-25-87 ^c (12)	8-17-87 ^b (4) 9-23-87 ^c (36)	--	--	
MD58-6 GW ES	8-13-87	8-25-87 ^c (12)	8-18-87 ^b (5) 9-24-87 ^c (37)	--	--	
MD58-7 GW ES	8-13-87	8-25-87 ^c (12)	8-18-87 ^b (5) 9-23-87 ^c (36)	--	--	
MD9-2 GW ES	8-12-87	8-25-87 ^c (13)	8-14-87 ^b (2) 9-15-87 ^c (32)	--	--	
MD9-3 GW ES	8-12-87	8-25-87 ^c (13)	8-14-87 ^b (2) 9-15-87 ^c (32)	--	--	

TABLE I.11 (Continued)
SUMMARY OF HOLDING TIMES FOR GROUND-WATER ANALYSES
FOR AUGUST 1987 SAMPLES

Field Sample Identifier	Date Sample Collected	Purgeable Organics E601/602 (8010/8020)	Date Analyzed (Holding Time in Days)			
			B/N/A	Extractables Organics E625	Petroleum Hydrocarbons E418.1	Lead E239.1
MD9-4 GW ES	8-11-87	8-24-87 ^c (13)		8-13-87 ^b (2) 9-9-87 ^c (25)	--	--
MD9-5 GW ES	8-12-87	8-25-87 ^c (13)		8-14-87 ^b (2) 9-14-87 ^c (31)	--	--
MD9-6 GW ES	8-12-87	8-24-87 ^c (12)		8-14-87 ^b (2) 9-14-87 ^c (31)	--	--
MD9-7 GW ES	8-12-87	8-25-87 ^c (13)		8-14-87 ^b (2) 9-14-87 ^c (31)	--	--
MD17-1 GW ES	8-14-87	8-28-87 ^c (14)		8-19-87 ^b (5) 9-25-87 ^c (37)	--	--
MD17-2 GW ES	8-14-87	8-28-87 ^c (14)		8-19-87 ^b (5) 9-25-87 ^c (37)	--	--
MD17-3 GW ES	8-14-87	8-28-87 ^c (14)		8-19-87 ^b (5) 9-25-87 ^c (37)	--	--
MD17-4 GW ES	8-14-87	8-28-87 ^c (14)		8-19-87 ^b (5) 9-25-87 ^c (37)	--	--
MD17-5 GW ES	8-14-87	8-28-87 ^c (14)		8-19-87 ^b (5) 9-26-87 ^c (38)	--	--

b - Date extracted

c - Date analyzed

TABLE I.12
SUMMARY OF HOLDING TIMES FOR SURFACE WATER ANALYSES
FOR AUGUST 1987 SAMPLES

Field Sample Identifier	Date Sample Collected	Date Analyzed (Holding Time in Days)			
		Purgeable Organics E601/602 (8010/8020)	Extractables Organics E625	Petroleum Hydrocarbons E418.1	Lead E239.1
MD9-SW1 ES	8-12-87	8-25-87 ^c (13)	8-14-87 ^b (2) 9-15-87 ^c (32)	-	--
MD9-SW2 ES	8-12-87	8-24-87 ^c (12)	8-14-87 ^b (2) 9-15-87 ^c (32)	-	--
MD9-SW3 ES	8-12-87	8-25-87 ^c (13)	8-14-87 ^b (2) 9-14-87 ^c (31)	-	--
MD9-SW4 ES	8-12-87	8-24-87 ^c (12)	8-14-87 ^b (2) 9-14-87 ^c (31)	-	--
MD17-SW3 ES	8-14-87	8-28-87 ^c (14)	8-19-87 ^b (5) 9-25-87 ^c (37)	-	--
MD17-SW4 ES	8-14-87	8-28-87 ^c (14)	8-20-87 ^b (6) 9-25-87 ^c (36)	-	--

b - Date extracted

c - Date analyzed

TABLE I.13
SUMMARY OF QUALITY CONTROL RESULTS
FOR AUGUST 1987 WATER SAMPLES

Compound	Number of Duplicates	Relative % Difference			Number of Spikes	Spike Concentration (ug/L)	Percent Recovery		
		Low	Average	High			Low	Average	High
EPA Method 601									
Bromodichloromethane	0	--	--	--	--	--	--	--	--
Bromoform	0	--	--	--	--	--	--	--	--
Bromethane	0	--	--	--	--	--	--	--	--
Carbon tetrachloride	0	--	--	--	--	--	--	--	--
Chlorobenzene	4	0	7	18	8	10	84	96	109
Chloroethane	0	--	--	--	--	--	--	--	--
2-Chloroethylvinyl ether	0	--	--	--	--	--	--	--	--
Chloroform	2	2.9	3.3	3.7	4	10	79	92	104
Chloromethane	0	--	--	--	--	--	--	--	--
Dibromochloromethane	0	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	0	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	0	--	--	--	--	--	--	--	--
1,4-Dichlorobenzene	0	--	--	--	--	--	--	--	--
Dichlorodifluoromethane	0	--	--	--	--	--	--	--	--
1,1-Dichloroethane	4	0.98	11	29	8	10	74	96	111
1,2-Dichloroethane	0	--	--	--	--	--	--	--	--
1,1-Dichloroethene	0	--	--	--	--	--	--	--	--
Trans-1,2-dichloroethene	0	--	--	--	--	--	--	--	--
1,2-Dichloropropane	0	--	--	--	--	--	--	--	--
Cis-1,3-dichloropropene	0	--	--	--	--	--	--	--	--
Trans-1,3-dichloropropene	0	--	--	--	--	--	--	--	--
Methylene chloride	2	1.2	7	12.7	4	10	81	85	92
1,1,2,2-Tetrachloroethane	0	--	--	--	--	--	--	--	--
Tetrachloroethene	0	--	--	--	--	--	--	--	--
1,1,1-Trichloroethane	0	--	--	--	--	--	--	--	--
1,1,2-Trichloroethane	0	--	--	--	--	--	--	--	--
Trichloroethene	2	11.2	12	11.9	4	10	87	96	103
Trichlorofluoromethane	0	--	--	--	--	--	--	--	--
Vinyl chloride	0	--	--	--	--	--	--	--	--

TABLE I.13 (Continued)
SUMMARY OF QUALITY CONTROL RESULTS
FOR AUGUST 1987 WATER SAMPLES

Compound	Number of Duplicates	Relative % Difference			Number of Spikes	Spike Concentration (ug/L)	Percent Recovery		
		Low	Average	High			Low	Average	High
EPA Method 602									
Benzene	3	--	ND	--	6	10	51	84	105
Chlorobenzene	1	--	ND	--	2	10	57	57	59
1,2-Dichlorobenzene	0	--	ND	--	--	--	--	--	--
1,3-Dichlorobenzene	0	--	ND	--	--	--	--	--	--
1,4-Dichlorobenzene	0	--	ND	--	--	--	--	--	--
Ethylbenzene	1	--	ND	--	2	10	57	60	62
Toluene	3	--	ND	--	6	10	55	86	108
Methods E625 and SW3550/8270									
1,2,4-Trichlorobenzene	4	--	ND	--	4	50	94	106	119
Acenaphthene	4	--	ND	--	4	50	106	118	128
2,4-Dinitrotoluene	4	--	ND	--	4	50	68	92	112
Pyrene	4	--	ND	--	4	50	98	120	146
N-Nitrosodi-n-propylamine	4	--	ND	--	4	50	92	130	150
1,4-Dichlorobenzene	4	--	ND	--	4	50	94	103	118
Pentachlorophenol	4	--	ND	--	4	100	6.2	28	54
Phenol	4	--	ND	--	4	100	37	55	72
2-Chlorophenol	4	--	ND	--	4	100	53	63	74
4-Chloro-3-methylphenol	4	--	ND	--	4	100	48	65	83
4-Nitrophenol	4	--	ND	--	4	100	1.6	12	27
EPA Method 418.1									
Petroleum Hydrocarbon	1	--	ND	--	1	0.50	--	108	--
EPA Methods 239.2									
Lead	1	--	4.7	--	2	20	105	108	110

TABLE I.14
SUMMARY OF QUALITY ASSURANCE RESULTS
MISCELLANEOUS PARAMETERS MEASURED IN GROUNDWATER AND SURFACE WATER
FOR AUGUST 1987 SAMPLES

Blind Duplicate Field Samples		Analytical Results		
Sample 1	Sample 2	Sample 1	Sample 2	Relative & Difference
<u>Purgeable Halocarbons ug/L (E601)</u>				
MDB-4 GN ES	MDB-6 GW ES	Methylene Chloride-0.71	Methylene Chloride -ND	--
MD58-6 GW ES	MD58-7 GW ES	Chloromethane - 29	Chloromethane - ND	--
MD17-3 GW ES	MD17-5 GW ES	Methylene Chloride-0.66	Methylene Chloride-ND	--
MDSW58-1 ES	MDSW58-6 FS	1,1-Dichloroethane- 2.1	1,1-Dichloroethane-ND	--
Field Blank	MDBL-1 GW FS	---	Methylene Chloride-0.68	--
<u>Purgeable Aromatics ug/L (E602)</u>				
MD58-6 GW ES	MD58-7 GW ES	ND	ND	--
MD17-3 GW ES	MD17-5 GW ES	ND	ND	--
MDSW58-1 ES	MDSW58-6 FS	ND	ND	--
<u>Aromatic Volatile Organics ug/L (SW 5030/8020)</u>				
MDB-4 GW ES	MDB-6 GW ES	ND	ND	--
Field Blank	MDBL-1 GW FS	--	Benzene - 3.6	--

Laboratory QA/QC
Data Sheets

Lab Sample Nos.

Duplicates MDB-1Spike STD. B.

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. QCV1Date Analyzed 10-10-86

Laboratory Supervisor Approval:

Tom StephensDilution Factor 1

*Moisture _____ %

Spike Source Supelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	ND	ND	ND		10	0	8.7	87	
Bromoform	ND	ND	ND		10	0	14.3	143	
Bromomethane	ND	ND	ND						
Carbon tetrachloride	ND	ND	ND						
Chlorobenzene	ND	ND	ND						
Chloroethane	ND	ND	ND						
2-Chloroethylvinyl ether	ND	ND	ND						
Chloroform	ND	ND	ND						
Chloromethane	ND	ND	ND						
Dibromochloromethane	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Dichlorodifluoromethane	ND	ND	ND						
1,1-Dichloroethane	ND	ND	ND						
1,2-Dichloroethane	ND	ND	ND						
1,1-Dichloroethene	ND	ND	ND						
trans-1,2-Dichloroethene	ND	ND	ND		10	0	7.7	77	
1,2-Dichloropropane	ND	ND	ND						
cis-1,3-Dichloropropene	ND	ND	ND						
trans-1,3-Dichloropropene	ND	ND	ND		10	0	6.9	69	
Methylene chloride	ND	ND	ND						
1,1,2,2-Tetrachloroethane	ND	ND	ND		10	0	9.9	99	
Tetrachloroethene	ND	ND	ND						
1,1,1-Trichloroethane	ND	ND	ND		10	0	9.9	99	
1,1,2-Trichloroethane	ND	ND	ND						
Trichloroethene	ND	ND	ND						
Trichlorofluoromethane	ND	ND	ND						
Vinyl chloride	ND	ND	ND						

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD)

$$= \frac{C1 - C2}{(C1 + C2)/2} \quad \begin{array}{l} C1 = \text{Concentration One} \\ C2 = \text{Concentration Two} \end{array}$$

Percent Recovery (PR) =

$$\frac{SSR - SR}{SA} \times 100$$

SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates MDB-1Spike STD BQC Report No. QCV1Date Analyzed 10-10

Laboratory Supervisor Approval: _____

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____Dilution Factor 1

*Moisture _____ %

Spike Source Sapelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Benzene	ND	ND	ND		10	0	10.4	104	
Chlorobenzene	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Ethylbenzene	ND	ND	ND		10	0	9.3	93	
Toluene	ND	ND	ND		10	0	10.0	100	

* If % moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2} \quad \begin{array}{l} C1 = \text{Concentration One} \\ C2 = \text{Concentration Two} \end{array}$$

$$\text{Percent Recovery (PR)} = \frac{SSR - SR}{SA} \times 100$$

SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates PL MD 58-5Spike STD. B.

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. OCV-2Date Analyzed 10-14-86

Laboratory Supervisor Approval:

Tom StephensDilution Factor 1

*Moisture _____ %

Spike Source Supelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	ND	ND	ND		10	0	7.7	77	
Bromoform	ND	ND	ND		10	0	10.1	101	
Bromomethane	ND	ND	ND						
Carbon tetrachloride	ND	ND	ND						
Chlorobenzene	ND	ND	ND						
Chloroethane	ND	ND	ND						
2-Chloroethylvinyl ether	ND	ND	ND						
Chloroform	ND	ND	ND						
Chloromethane	ND	ND	ND						
Dibromochloromethane	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Dichlorodifluoromethane	ND	ND	ND						
1,1-Dichloroethane	ND	ND	ND						
1,2-Dichloroethane	ND	ND	ND						
1,1-Dichloroethene	ND	ND	ND						
trans-1,2-Dichloroethene	ND	ND	ND		10	0	6.4	64	
1,2-Dichloropropane	ND	ND	ND						
cis-1,3-Dichloropropene	ND	ND	ND						
trans-1,3-Dichloropropene	ND	ND	ND		10	0	6.9	69	
Methylene chloride	ND	ND	ND						
1,1,2,2-Tetrachloroethane	ND	ND	ND		10	0	7.5	75	
Tetrachloroethene	ND	ND	ND						
1,1,1-Trichloroethane	ND	ND	ND		10	0	8.4	84	
1,1,2-Trichloroethane	ND	ND	ND						
Trichloroethene	ND	ND	ND						
Trichlorofluoromethane	ND	ND	ND						
Vinyl chloride	ND	ND	ND						

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates DLMD.58-5Spike STD BQC Report No. QCV2Date Analyzed 10-14

Laboratory Supervisor Approval: _____

Sample Matrix:

☒ Water (ug/L)Dilution Factor 1☐ Soil (ug/g) (ug/Kg)

*Moisture _____ %

☐ Other _____Spike Source Sapelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Benzene	ND	ND	ND		10	0	9.8	98	
Chlorobenzene	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Ethylbenzene	ND	ND	ND		10	0	9.0	90	
Toluene	ND	ND	ND		10	0	9.5	95	

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates PLMD58-1Spike STD. B.

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. QCV-3Date Analyzed 10-15-86

Laboratory Supervisor Approval:

Tom StephensDilution Factor 1

*Moisture _____ %

Spike Source Supelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	ND	ND	ND		10	0	7.8	78	
Bromoform	ND	ND	ND		10	0	9.5	95	
Bromomethane	ND	ND	ND						
Carbon tetrachloride	ND	ND	ND						
Chlorobenzene	ND	ND	ND						
Chloroethane	ND	ND	ND						
2-Chloroethylvinyl ether	ND	ND	ND						
Chloroform	ND	ND	ND						
Chloromethane	ND	ND	ND						
Dibromochloromethane	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Dichlorodifluoromethane	ND	ND	ND						
1,1-Dichloroethane	ND	ND	ND						
1,2-Dichloroethane	ND	ND	ND						
1,1-Dichloroethene	ND	ND	ND						
trans-1,2-Dichloroethene	ND	ND	ND		10	0	8.7	87	
1,2-Dichloropropane	ND	ND	ND						
cis-1,3-Dichloropropene	ND	ND	ND						
trans-1,3-Dichloropropene	ND	ND	ND		10	0	8.4	84	
Methylene chloride	ND	ND	ND						
1,1,2,2-Tetrachloroethane	ND	ND	ND		10	0	9.5	95	
Tetrachloroethene	ND	ND	ND						
1,1,1-Trichloroethane	ND	ND	ND		10	0	11.4	114	
1,1,2-Trichloroethane	ND	ND	ND						
Trichloroethene	ND	ND	ND						
Trichlorofluoromethane	ND	ND	ND						
Vinyl chloride	ND	ND	ND						

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD)

$$= \frac{C1 - C2}{(C1 + C2)/2} \quad \begin{array}{l} C1 = \text{Concentration One} \\ C2 = \text{Concentration Two} \end{array}$$

Percent Recovery (PR) =

$$\frac{SSR - SR}{SA} \times 100$$

SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates PLMD58-1Spike STD BQC Report No. QCVEDate Analyzed 10-15

Laboratory Supervisor Approval: _____

Sample Matrix:

☒ Water (ug/L)Dilution Factor 1☐ Soil (ug/g) (ug/Kg)

*Moisture _____ %

☐ Other _____Spike Source Sapelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Benzene	ND	ND	ND		10	0	11.4	114	
Chlorobenzene	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Ethylbenzene	ND	ND	ND		10	0	11.2	112	
Toluene	ND	ND	ND		10	0	11.1	111	

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Lab Sample Nos.

QC Report No. OCV-4Duplicates RLMD9-4Date Analyzed 10-16-86Spike STD.B.

Laboratory Supervisor Approval:

Sample Matrix:

Tom Stephens☒ Water (ug/L)Dilution Factor 1☐ Soil (ug/g) (ug/Kg)

*Moisture _____ %

☐ Other _____Spike Source Supelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	ND	ND	ND		10	0	7.3	73	
Bromoform	ND	ND	ND		10	0	9.4	94	
Bromomethane	ND	ND	ND						
Carbon tetrachloride	ND	ND	ND						
Chlorobenzene	ND	ND	ND						
Chloroethane	ND	ND	ND						
2-Chloroethylvinyl ether	ND	ND	ND						
Chloroform	ND	ND	ND						
Chloromethane	ND	ND	ND						
Dibromochloromethane	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Dichlorodifluoromethane	ND	ND	ND						
1,1-Dichloroethane	ND	ND	ND						
1,2-Dichloroethane	ND	ND	ND						
1,1-Dichloroethene	ND	ND	ND						
trans-1,2-Dichloroethene	ND	ND	ND		10	0	8.1	81	
1,2-Dichloropropane	ND	ND	ND						
cis-1,3-Dichloropropene	ND	ND	ND						
trans-1,3-Dichloropropene	ND	ND	ND		10	0	8.3	83	
Methylene chloride	ND	ND	ND						
1,1,2,2-Tetrachloroethane	ND	ND	ND		10	0	9.6	96	
Tetrachloroethene	ND	ND	ND						
1,1,1-Trichloroethane	ND	ND	ND		10	0	10.4	104	
1,1,2-Trichloroethane	ND	ND	ND						
Trichloroethene	ND	ND	ND						
Trichlorofluoromethane	ND	ND	ND						
Vinyl chloride	ND	ND	ND						

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD)

$$= \frac{C1 - C2}{(C1 + C2)/2} \quad \begin{array}{l} C1 = \text{Concentration One} \\ C2 = \text{Concentration Two} \end{array}$$

Percent Recovery (PR) =

$$\frac{SSR - SR}{SA} \times 100$$

SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates RLMD9-4Spike STD BQC Report No. QCV4Date Analyzed 10-16

Laboratory Supervisor Approval: _____

Sample Matrix:

/X/ Water (ug/L)/ Soil (ug/g) (ug/Kg)/ Other _____Dilution Factor 1

*Moisture _____ %

Spike Source Sapelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Benzene	ND	ND	ND		10	0	10.3	103	
Chlorobenzene	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Ethylbenzene	ND	ND	ND		10	0	10.2	102	
Toluene	ND	ND	ND		10	0	10.3	103	

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates FAMD23-12Spike STD.B.

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. QCV-5Date Analyzed 10-17-86

Laboratory Supervisor Approval:

Tom StephensDilution Factor 1

*Moisture _____ %

Spike Source Supelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	ND	ND	ND		10	0	12.3	123	
Bromoform	ND	ND	ND		10	0	17.6	176	
Bromomethane	ND	ND	ND						
Carbon tetrachloride	ND	ND	ND						
Chlorobenzene	ND	ND	ND						
Chloroethane	ND	ND	ND						
2-Chloroethylvinyl ether	ND	ND	ND						
Chloroform	ND	ND	ND						
Chloromethane	ND	ND	ND						
Dibromochloromethane	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Dichlorodifluoromethane	ND	ND	ND						
1,1-Dichloroethane	ND	ND	ND						
1,2-Dichloroethane	ND	ND	ND						
1,1-Dichloroethene	ND	ND	ND						
trans-1,2-Dichloroethene	ND	ND	ND		10	0	11.5	115	
1,2-Dichloropropane	ND	ND	ND						
cis-1,3-Dichloropropene	ND	ND	ND						
trans-1,3-Dichloropropene	ND	ND	ND		10	0	14.4	144	
Methylene chloride	ND	ND	ND						
1,1,2,2-Tetrachloroethane	ND	ND	ND		10	0	19.3	193	
Tetrachloroethene	ND	ND	ND						
1,1,1-Trichloroethane	ND	ND	ND		10	0	14.3	143	
1,1,2-Trichloroethane	ND	ND	ND						
Trichloroethene	ND	ND	ND						
Trichlorofluoromethane	ND	ND	ND						
Vinyl chloride	ND	ND	ND						

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates FAMD23-12Spike STD BQC Report No. QCV5Date Analyzed 10-17

Laboratory Supervisor Approval: _____

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____Dilution Factor 1

*Moisture _____ %

Spike Source Sapelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Benzene	ND	ND	ND		10	0	11.8	118	
Chlorobenzene	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Ethylbenzene	ND	ND	ND		10	0	7.1	71	
Toluene	ND	ND	ND		10	0	11.6	116	

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates FAMD23-8Spike STD.B.

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. QCV-6Date Analyzed 10-18-86

Laboratory Supervisor Approval:

Tom StephensDilution Factor 1

*Moisture _____ %

Spike Source Supelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	ND	ND	ND		10	0	6.8	68	
Bromoform	ND	ND	ND		10	0	8.7	87	
Bromomethane	ND	ND	ND						
Carbon tetrachloride	ND	ND	ND						
Chlorobenzene	ND	ND	ND						
Chloroethane	ND	ND	ND						
2-Chloroethylvinyl ether	ND	ND	ND						
Chloroform	ND	ND	ND						
Chloromethane	ND	ND	ND						
Dibromochloromethane	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Dichlorodifluoromethane	ND	ND	ND						
1,1-Dichloroethane	ND	ND	ND						
1,2-Dichloroethane	ND	ND	ND						
1,1-Dichloroethene	ND	ND	ND						
trans-1,2-Dichloroethene	ND	ND	ND		10	0	5.4	54	
1,2-Dichloropropane	ND	ND	ND						
cis-1,3-Dichloropropene	ND	ND	ND						
trans-1,3-Dichloropropene	ND	ND	ND		10	0	7.3	73	
Methylene chloride	ND	ND	ND						
1,1,2,2-Tetrachloroethane	ND	ND	ND		10	0	6.5	65	
Tetrachloroethene	ND	ND	ND						
1,1,1-Trichloroethane	ND	ND	ND		10	0	7.6	76	
1,1,2-Trichloroethane	ND	ND	ND						
Trichloroethene	ND	ND	ND						
Trichlorofluoromethane	ND	ND	ND						
Vinyl chloride	ND	ND	ND						

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates FAMD2.3-8Spike STD BQC Report No. QCV6Date Analyzed 10-18

Laboratory Supervisor Approval: _____

Sample Matrix:

☒ /X/ Water (ug/L)☐ / Soil (ug/g) (ug/Kg)☐ / Other _____Dilution Factor 1

*Moisture _____

Spike Source Sapelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Benzene	ND	ND	ND		10	0	9.9	99	
Chlorobenzene	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Ethylbenzene	ND	ND	ND		10	0	8.7	87	
Toluene	ND	ND	ND		10	0	9.3	93	

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates FAMD23-10Spike STD.B.

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. QCV-7Date Analyzed 10-20-86

Laboratory Supervisor Approval:

Tom StephensDilution Factor 1

*Moisture _____

Spike Source Supelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	ND	ND	ND		10	0	9.2	92	
Bromoform	ND	ND	ND		10	0	10.8	108	
Bromomethane	ND	ND	ND						
Carbon tetrachloride	ND	ND	ND						
Chlorobenzene	ND	ND	ND						
Chloroethane	ND	ND	ND						
2-Chloroethylvinyl ether	ND	ND	ND						
Chloroform	ND	ND	ND						
Chloromethane	ND	ND	ND						
Dibromochloromethane	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Dichlorodifluoromethane	ND	ND	ND						
1,1-Dichloroethane	ND	ND	ND						
1,2-Dichloroethane	ND	ND	ND						
1,1-Dichloroethene	ND	ND	ND						
trans-1,2-Dichloroethene	ND	ND	ND		10	0	9.9	99	
1,2-Dichloropropane	ND	ND	ND						
cis-1,3-Dichloropropene	ND	ND	ND						
trans-1,3-Dichloropropene	ND	ND	ND		10	0	9.0	90	
Methylene chloride	ND	ND	ND						
1,1,2,2-Tetrachloroethane	ND	ND	ND		10	0	11.2	112	
Tetrachloroethene	ND	ND	ND						
1,1,1-Trichloroethane	ND	ND	ND		10	0	12.5	125	
1,1,2-Trichloroethane	ND	ND	ND						
Trichloroethene	ND	ND	ND						
Trichlorofluoromethane	ND	ND	ND						
Vinyl chloride	ND	ND	ND						

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD)

$$= \frac{C1 - C2}{(C1 + C2)/2}$$

C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) =

$$\frac{SSR - SR}{SA} \times 100$$

SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates FAMD23-10Spike STD BQC Report No. QCV7Date Analyzed 10-20Laboratory Supervisor Approval:

Sample Matrix:

/X/ Water (ug/L) Soil (ug/g) (ug/Kg) Other Dilution Factor 1*Moisture %Spike Source Sapelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Benzene	ND	ND	ND		10	0	10.5	105	
Chlorobenzene	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Ethylbenzene	ND	ND	ND		10	0	9.6	96	
Toluene	ND	ND	ND		10	0	9.9	99	

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates RLMD9 SW-1Spike STD.B.QC Report No. OCV-8Date Analyzed 10-22-86

Laboratory Supervisor Approval:

Tom Stephens

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____Dilution Factor 1

*Moisture _____ %

Spike Source Supelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	ND	ND	ND		10	0	7.5	75	
Bromoform	ND	ND	ND		10	0	6.3	63	
Bromomethane	ND	ND	ND						
Carbon tetrachloride	ND	ND	ND						
Chlorobenzene	ND	ND	ND						
Chloroethane	ND	ND	ND						
2-Chloroethylvinyl ether	ND	ND	ND						
Chloroform	ND	ND	ND						
Chloromethane	ND	ND	ND						
Dibromochloromethane	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Dichlorodifluoromethane	ND	ND	ND						
1,1-Dichloroethane	ND	ND	ND						
1,2-Dichloroethane	ND	ND	ND						
1,1-Dichloroethene	ND	ND	ND						
trans-1,2-Dichloroethene	ND	ND	ND		10	0	7.2	72	
1,2-Dichloropropane	ND	ND	ND						
cis-1,3-Dichloropropene	ND	ND	ND						
trans-1,3-Dichloropropene	ND	ND	ND		10	0	6.1	61	
Methylene chloride	ND	ND	ND						
1,1,2,2-Tetrachloroethane	ND	ND	ND		10	0	3.9	39	
Tetrachloroethene	ND	ND	ND						
1,1,1-Trichloroethane	ND	ND	ND		10	0	10.0	100	
1,1,2-Trichloroethane	ND	ND	ND						
Trichloroethene	ND	ND	ND						
Trichlorofluoromethane	ND	ND	ND						
Vinyl chloride	ND	ND	ND						

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD)

$$= \frac{C1 - C2}{(C1 + C2)/2}$$

C1 = Concentration One

C2 = Concentration Two

Percent Recovery (PR) =

$$\frac{SSR - SR}{SA} \times 100$$

SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates RLMD9.SW-1Spike STD BQC Report No. QCV8Date Analyzed 10-22

Laboratory Supervisor Approval: _____

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____Dilution Factor 1

*Moisture _____ %

Spike Source Sapelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Benzene	ND	ND	ND		10	0	11.0	110	
Chlorobenzene	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Ethylbenzene	ND	ND	ND		10	0	10.6	106	
Toluene	ND	ND	ND		10	0	10.8	108	

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates CMMD11-SW-1Spike STD.C.

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. OCV-9Date Analyzed 10-23-86

Laboratory Supervisor Approval:

Tom StephensDilution Factor 1

*Moisture _____ %

Spike Source Supelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	ND	ND	ND						
Bromoform	ND	ND	ND						
Bromomethane	ND	ND	ND		10	0	10.2	102	
Carbon tetrachloride	ND	ND	ND						
Chlorobenzene	ND	ND	ND						
Chloroethane	ND	ND	ND		10	0	9.7	97	
2-Chloroethylvinyl ether	ND	ND	ND						
Chloroform	ND	ND	ND						
Chloromethane	ND	ND	ND		10	0	10.7	107	
Dibromochloromethane	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Dichlorodifluoromethane	ND	ND	ND						
1,1-Dichloroethane	ND	ND	ND						
1,2-Dichloroethane	ND	ND	ND						
1,1-Dichloroethene	ND	ND	ND						
trans-1,2-Dichloroethene	ND	ND	ND						
1,2-Dichloropropane	ND	ND	ND						
cis-1,3-Dichloropropene	ND	ND	ND						
trans-1,3-Dichloropropene	ND	ND	ND						
Methylene chloride	ND	ND	ND						
1,1,2,2-Tetrachloroethane	ND	ND	ND						
Tetrachloroethene	ND	ND	ND						
1,1,1-Trichloroethane	ND	ND	ND						
1,1,2-Trichloroethane	ND	ND	ND						
Trichloroethene	ND	ND	ND						
Trichlorofluoromethane	ND	ND	ND						
Vinyl chloride	ND	ND	ND		10	0	9.5	95	

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$

SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Added (Concentration)

Lab Sample Nos.

QC Report No. QCV-9Duplicates CMMDH-SW-1Date Analyzed 10/23/86Spike STD C

Laboratory Supervisor Approval: _____

Sample Matrix:

/X/ Water (ug/L)Dilution Factor 1/ Soil (ug/g) (ug/Kg)

*Moisture _____ %

/ Other _____Spike Source Supelco Std.

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Benzene	ND	ND	ND						
Chlorobenzene	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Ethylbenzene	ND	ND	ND						
Toluene	ND	ND	ND						

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates ACAP7.2Spike STD.C.

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. OCV-10Date Analyzed 10-29-86

Laboratory Supervisor Approval:

Tom StephensDilution Factor 1

*Moisture _____ %

Spike Source Supelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	ND	ND	ND						
Bromoform	ND	ND	ND						
Bromomethane	ND	ND	ND		10	0	9.4	94	
Carbon tetrachloride	ND	ND	ND						
Chlorobenzene	ND	ND	ND						
Chloroethane	ND	ND	ND		10	0	9.9	99	
2-Chloroethylvinyl ether	ND	ND	ND						
Chloroform	ND	ND	ND						
Chloromethane	ND	ND	ND		10	0	9.9	99	
Dibromochloromethane	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Dichlorodifluoromethane	ND	ND	ND						
1,1-Dichloroethane	ND	ND	ND						
1,2-Dichloroethane	ND	ND	ND						
1,1-Dichloroethene	ND	ND	ND						
trans-1,2-Dichloroethene	ND	ND	ND						
1,2-Dichloropropane	ND	ND	ND						
cis-1,3-Dichloropropene	ND	ND	ND						
trans-1,3-Dichloropropene	ND	ND	ND						
Methylene chloride	ND	ND	ND						
1,1,2,2-Tetrachloroethane	ND	ND	ND						
Tetrachloroethene	ND	ND	ND						
1,1,1-Trichloroethane	ND	ND	ND						
1,1,2-Trichloroethane	ND	ND	ND						
Trichloroethene	ND	ND	ND						
Trichlorofluoromethane	ND	ND	ND						
Vinyl chloride	ND	ND	ND		10	0	9.9	99	

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates ACAP7-2Spike STD C

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. QCV-10Date Analyzed 10/29/86

Laboratory Supervisor Approval: _____

Dilution Factor 1

*Moisture _____ %

Spike Source Supelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Benzene	ND	ND	ND						
Chlorobenzene	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Ethylbenzene	ND	ND	ND						
Toluene	ND	ND	ND						

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates AOAP6-5Spike STD.C.

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. OCV-11Date Analyzed 10-31-86

Laboratory Supervisor Approval:

Tom StephensDilution Factor 1

*Moisture _____ %

Spike Source Supelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	ND	ND	ND						
Bromoform	ND	ND	ND						
Bromomethane	ND	ND	ND		10	0	16.9	169	
Carbon tetrachloride	ND	ND	ND						
Chlorobenzene	ND	ND	ND						
Chloroethane	ND	ND	ND		10	0	11.6	116	
2-Chloroethylvinyl ether	ND	ND	ND						
Chloroform	ND	ND	ND						
Chloromethane	ND	ND	ND		10	0	12.1	121	
Dibromochloromethane	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Dichlorodifluoromethane	ND	ND	ND						
1,1-Dichloroethane	ND	ND	ND						
1,2-Dichloroethane	ND	ND	ND						
1,1-Dichloroethene	ND	ND	ND						
trans-1,2-Dichloroethene	ND	ND	ND						
1,2-Dichloropropane	ND	ND	ND						
cis-1,3-Dichloropropene	ND	ND	ND						
trans-1,3-Dichloropropene	ND	ND	ND						
Methylene chloride	ND	ND	ND						
1,1,2,2-Tetrachloroethane	ND	ND	ND						
Tetrachloroethene	ND	ND	ND						
1,1,1-Trichloroethane	ND	ND	ND						
1,1,2-Trichloroethane	ND	ND	ND						
Trichloroethene	ND	ND	ND						
Trichlorofluoromethane	ND	ND	ND						
Vinyl chloride	ND	ND	ND		10	0	10.0	100	

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates AOAP6-5Spike STD C

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. QC-11Date Analyzed 10-31-86

Laboratory Supervisor Approval: _____

Dilution Factor 1

*Moisture _____ %

Spike Source Sapelco STD

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Benzene	ND	ND	ND						
Chlorobenzene	ND	ND	ND						
1,2-Dichlorobenzene	ND	ND	ND						
1,3-Dichlorobenzene	ND	ND	ND						
1,4-Dichlorobenzene	ND	ND	ND						
Ethylbenzene	ND	ND	ND						
Toluene	ND	ND	ND						

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Mr. Mark Guthrie
Engineering-Science
57 Executive Park South., Suite 590
Atlanta, Georgia 30329

QC Report - Matrix Spikes (8240)

Page 1

LOG NO	SAMPLE DESCRIPTION	SAMPLED BY	
1001-1	QC Report - QCMSV1	Client	
1001-2	QC Report - QCMSV2		
PARAMETER		1001-1	1001-2
CLP Matrix Spike - Volatiles			
1,1-Dichloroethene, % Rec.		75	82
Trichloroethene, % Rec.		126	101
Chlorobenzene, % Rec.		69	96
Toluene, % Rec.		71	85
Benzene, % Rec.		76	87

J. W. Andrews
J. W. Andrews, Ph. D.

Mr. Mark Guthrie
 Engineering-Science
 57 Executive Park South, Suite 590
 Atlanta, Georgia 30329

QC Report - Matrix Spikes (625/8270)

Page 1

LOG NO	SAMPLE DESCRIPTION	SAMPLED BY				
1000-1	QC Report - QCMS2668	Client				
1000-2	QC Report - QCSV6					
1000-3	QC Report - QCMS2603S					
1000-4	QC Report - QCMS2603					
1000-5	QC Report - QCSV2613					
PARAMETER	1000-1	1000-2	1000-3	1000-4	1000-5	
CLP Matrix Spike Semivolatiles						
1,2,4-Trichlorobenzene, % Rec	66	64	92	62	19	
Acenaphthene, % Rec	57	66	76	64	71	
2,4-Dinitrotoluene, % Rec	71	61	92	59	161	
Pyrene, % Rec	92	64	76	79	95	
N-Nitrosodi-N-Propylamine, % Rec	95	67	98	60	45	
1,4-Dichlorobenzene, % Rec	65	59	NC	58	NC	
Pentachlorophene, % Rec	68	66	34	68	62	
Phenol, % Rec	67	63	NC	67	NC	
2-Chlorophenol, % Rec	19	62	NC	117	NC	
4-Chloro-3-methylphenol, % Rec	30	63	36	116	47	
4-Nitrophenol, % Rec	NC	22	41	41	17	

Mr. Mark Guthrie
 Engineering-Science
 37 Executive Park South, Suite 390
 Atlanta, Georgia 30329

QC Report - Matrix Spikes (625/8270)

Page 2

LOG NO	SAMPLE DESCRIPTION	SAMPLED BY		
1000-6	QC Report - QCMS2703	Client		
1000-7	QC Report - QCSV10			
1000-8	QC Report - QCSV11			
PARAMETER		1000-6	1000-7	1000-8
CLP Matrix Spike Semivolatiles				
1,2,4-Trichlorobenzene, % Rec.		111	97	28
Acenaphthene, % Rec.		85	76	65
2,4-Dinitrotoluene, % Rec.		104	80	84
Pyrene, % Rec.		89	115	58
N-Nitrosodi-N-Propylamine, % Rec.		93	82	49
1,4-Dichlorobenzene, % Rec.		NC	64	NC
Pentachlorophenol, % Rec.		38	84	24
Phenol, % Rec.		NC	30	NC
2-Chlorophenol, % Rec.		NC	14	NC
4-Chloro-3-methylphenol, % Rec.		39	27	36
4-Nitrophenol, % Rec.		19	NC	84

J. W. Andrews

J. W. Andrews Ph. D.

QUALITY CONTROL RESULTS SUMMARY

Page 1 of 1
Report

QC Report No. QCEDB5

Laboratory Supervisor Approval:

Laboratory Supervisor Approval:

J. W. Brown

1

[illegible]

* If moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2}$$

$$\text{Percent Recovery (PR)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

SSR = Spiked Sample Result
 SR = Sample Result
 SA = Spike Added (Concentration)

Engineering-Science

QUALITY CONTROL RESULTS SUMMARY
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Sample Matrix:

☒ Water (mg/L) (mg/l)

Dilution Factor

☐ Soil (ug/g) (ug/kg)

Moisture

☐ Other

Spike Source(s)

QC Report No. QCML2

Laboratory Supervisor Approval:

J.W. Adams

Analytical Parameter	Laboratory Sample Nos.		Date Anal	Anal Method	Blank	Dilution		Spike		Recovery	PR	Notes
	Duplicates	Spike				C1	C2	SA	SR			
Pb	2562-7	2562-7		239.2	<.005	<.005	<.005	0.1	<.005	0.11	110	
Cd	"	"		213.2	<.0005	<.0005	<.0005	0.05	<.0005	0.047	94	
Cr	"	"		218.2	<.05	<.05	<.05	0.5	<.05	0.46	92	
Zn	"	"		289.1	<.02	<.02	<.02	0.5	<.02	0.52	104	
Pb	2615-8	2615-8		239.2	<.005	<.005	<.005	0.1	<.005	0.10	100	
Metal Scan (See QCM-11)												

* If % moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2} \quad C1 = \text{Concentration One} \quad C2 = \text{Concentration Two}$$

$$\text{Percent Recovery (PR)} = \frac{SR - SA}{SA} \times 100 \quad SR = \text{Spiked Sample Result} \quad SA = \text{Sample Result} \quad SP = \text{Spike Added (Concentration)}$$

Engineering-Science

QUALITY CONTROL RESULTS SUMMARY
MetalsPage 1 of 2
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Sample Matrix:

X Water (mg/L) (mg/l)

Dilution Factor

/ Soil (ug/g) (ug/kg)

Moisture

/ Other

Spike Source(s)

QC Report No. QC-N11

Laboratory Supervisor Approval:

J.W. Carter

Analyte Metal	Laboratory Sample No.		Date Anal	Anal Method	Blank	Duplications*			Spike Recovery			Notes
	Duplicate	Spike				C1	C2	RPD	SA	SR	PR	
Al	2562-2	2562-2		200.7+AA Furnace	<0.01	3.0	3.0	0	10	3.0	12.2	92
As	"	"		"	<0.01	<0.01	<0.01		0.1	<0.01	0.081	81
Ba	"	"		"	<0.05	0.08	0.08	0	1.0	0.08	0.91	91
Be	"	"		"	<0.01	<0.01	<0.01		0.1	<0.01	0.11	110
B	"	"		"	<0.05	1.2	1.0	18	1.0	1.1	2.3	120
Cd	"	"		"	<0.01	<0.01	<0.01		0.1	<0.01	0.09	90
Ca	"	"		"	0.06	100	100	0	100	100	210	110
Cr	"	"		"	<0.05	<0.05	<0.05		0.5	<0.05	0.47	94
Cu	"	"		"	<0.05	<0.05	<0.05		0.5	<0.05	0.49	98
Fe	"	"		"	<0.05	14	14	0	10	14	23	90
Pb	"	"		"	<0.01	<0.01	<0.01		0.1	<0.01	0.08	80
Rg	"	"		"	<0.05	28	26	7.4	1.0	<0.05	0.92	92

* If % moisture is reported, results are presented on a dry-weight basis.

** F = Flame AAS

G = Graphite Furnace AAS

H = Hydride Vapor AAS

C = Cold Vapor AAS

P = Inductively Coupled Plasma

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2} \times 100$ Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$

SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Added (Concentration)

059J111

* All ICP analyses were in triplicate and furnace analyses were in duplicate

Engineering-Science

QUALITY CONTROL RESULTS SUMMARY Environmental Quality Parameters

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Sample Matrix:

X Water (mg/L) (mg/l)

Dilution Factor

/ Soil (ug/g) (ug/Kg)

Moisture

/ Other

QC Report No. QCM11

Laboratory Supervisor Approval:

Spike Sources:

Analytical Parameter	Laboratory Sample No.		Date Anal	Anal Method	Blank	Duplication		Spike Recovery			Notes
	Duplication	Spike				C1	C2	SA	SR	PR	
Mn	2562-2	2562-2		200.7 furnace	<0.05	<0.05	<0.05	1.0	<0.05	1.1	
Mo	"	"		"	<0.01	<0.01	<0.01	0.1	<0.01	0.11	
NI	"	"		"	<0.05	<0.05	<0.05	1.0	<0.05	1.2	
K	"	"		"	<1	36	39	10	38	49	
Se	"	"		"	<0.01	<0.01	<0.01	0.1	<0.01	0.09	
SI	"	"		"	<1	18	18	10	18	26	
Ag	"	"		"	<0.05	<0.05		0.1	<0.05	0.10	
Na	"	"		"	<1.0	68	62	10	65	72	
TT	"	"		"	<0.5	<0.5	<0.5	1	<0.5	1.1	

* If a moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2} \quad C1 = \text{Concentration One} \quad C2 = \text{Concentration Two}$$

$$\text{Percent Recovery (PR)} = \frac{SR - SA}{SA} \times 100 \quad SR = \text{Spike Sample Result} \quad SA = \text{Spike Added (Concentration)}$$

QUALITY CONTROL, RESULTS SUMMARY

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QC Report No. QC-M111

continued

Executive Summary

!111 kn :kuv:uo(n)

[illegible]

* If a solution is reported, results are presented on a dry-weight basis.

$$\text{Relative Fluorescence (RFP)} = \frac{C_1 - C_2}{(C_1 + C_2)/2}$$

$$\text{Percent Recovery (pr)} = \frac{\text{SSR} - \text{SS}}{\text{SS}} \times 100$$

Engineering-Balance

QUALITY CONTROL RESULTS SUMMARY
Environmental Quality Parameters

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Sample Matrix:

☒ X/ Water (ug/L) (mg/L) Dilution Factor

☒ X/ Soil (ug/kg) (mg/L) Moisture

☒ Other (in EP)

Spike Source(s)

QC Report No. QC ML3

Laboratory Supervisor Approval:

J. W. Anderson

Analytical Parameter	Laboratory Sample Nos.		Date Anal	Anal Method	Blank	Duplicate		Spike Recovery			Notes
	Duplicate	Spike				C1	C2	RA	RR	PN	
Pb	2538-1	2538-1	10/22	239.2	<0.005	<0.005		0.1	<0.005	0.11	110
As	2658-5	2658-5		1310/	<0.01	<0.01	<0.01	0.1	<0.01	0.08	80
Ba	"	"		6010/	<0.05	<0.05	<0.05	0.5	<0.05	0.48	98
Cd	"	"		"	<0.005	<0.005	<0.005	0.1	<0.005	0.10	100
Cr	"	"		"	<0.05	<0.05	<0.05	0.5	<0.05	0.48	98
Pb	"	"		"	<0.05	<0.05	<0.05	0.5	<0.05	0.52	104
Se	"	"		"	<0.01	<0.01	<0.01	0.1	<0.01	0.11	110
Ag	"	"		"	<0.01	<0.01	<0.01	0.1	<0.01	0.08	80
Hg	"	"		"	<0.002	<0.002	<0.002	0.001	<0.002	0.008	80

* If a moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2} \quad C1 = \text{Concentration One} \quad C2 = \text{Concentration Two}$$

$$\text{Percent Recovery (PN)} = \frac{RR - RA}{RA} \times 100 \quad RR = \text{Spiked Sample Result} \quad RA = \text{Sample Result} \quad RA = \text{Spike Added (Concentration)}$$

QUALITY CONTROL RESULTS SUMMARY

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QC Report No. QC M15

Dilution Factor

Moisture 73% Solids

J. W. Anderson

Laboratory Supervisor Approval:

[illegible]

* If moisture is reported, results are presented on a dry-weight basis.

FF - Flame VAS

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2}$$

C1 = Concentration One
C2 = Concentration Two

G = Graphite Furnace AAS

III - Hydride Vapor AAS

C = Cold Vapor AMS

P = Inductively Coupled Plasma

$$\text{Percent Recovery (PR)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

SSR = Spiked Sample Result
SR = Sample Result
SA = Sample Area

USR - Spiked Sample

SR = Sample Result

SA = Spike Added (Concentration)

Engineering-Science

QUALITY CONTROL RESULTS SUMMARY Environmental Quality Parameters

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Sample Matrix:

Water (ug/L) Dilution Factor

Soil (mg/kg) (mg/L in solution)
EP

Other

QC Report No. QCM16

Laboratory Supervisor Approval:

J.W. Anderson

Spike Source(s)

Analytical Parameter	Laboratory Sample Nos.		Date Anal	Anal Method	Blank	Duplicate		Spike Recovery			Notes
	Duplicate	Spike				C1	C2	SA	SR	PR	
As	2672-30	2672-30		1310/	<0.01	<0.01	<0.01	0.1	<0.01	0.08	80
Ba	"	"		6010/	<0.05	<0.05	<0.05	0.5	<0.05	0.53	106
Cd	"	"			<0.005	<0.005	<0.005	0.1	<0.05	0.09	90
Cr	"	"			<0.05	<0.05	<0.05	0.5	<0.05	0.43	86
Pb	"	"			<0.05	<0.05	<0.05	0.5	<0.05	0.49	98
Se	"	"			<0.01	<0.01	<0.01	0.1	<0.01	0.10	100
As	"	"			<0.01	<0.01	<0.01	0.1	<0.01	0.09	90
Hg	"	"			<0.0002	<0.0002	<0.0002	0.001	<0.0002	0.001	100

* If a solution is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2} \quad C1 = \text{Concentration One} \quad C2 = \text{Concentration Two}$$

$$\text{Percent Recovery (PR)} = \frac{SR - SA}{SA} \times 100 \quad SR = \text{Spiked Sample Result} \quad SA = \text{Spiked Added (Concentration)}$$

QC Report No. QC M17S

Laboratory Supervisor Approval:

J. W. Anderson

QUALITY CONTROL RESULTS SUMMARY

Sample Matrix:		Dilution Factor	Moisture
<u> X </u>	Water (<u>XXX</u> ml)		
<u> X </u>	Soil (ug/g)		
<u> X </u>	Other		
Spike Source(s)		Fisher	

[illegible]

^a If moisture is reported, results are presented on a dry-weight basis.

♦♦ F - Flame VAS

G = Graphite Furnace AAS

Hydride Vapor AAS

C = Cold Vapor AAS

P = Inductively Coupled Plasma

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2}$$

Percent Recovery (PR) = $\frac{SSR - SR}{SSR} \times 100$	Spiked Sample Result	Result
100	100	100
90	90	90
80	80	80
70	70	70
60	60	60
50	50	50
40	40	40
30	30	30
20	20	20
10	10	10
0	0	0

SN - Sample Result

SSA = Spike Added (Concentration)

Sample Matrix:

/X/ Water ($\frac{\mu\text{g}}{\text{L}}$) (mg/L) Dilution Factor/ / Soil ($\mu\text{g/g}$) ($\mu\text{g/Kg}$) *Moisture

/ / other

Spike Source(s)

QC Report No. QCM20

Laboratory Supervisor Approval:

J.W. Anderson

Analyte Metal	Laboratory Sample Nos.		Date Anal	**Anal Method	Blank	Duplicates		Spike			Notes
	Duplicates	Spike				C1	C2	SA	SR	PR	
Al	2554-1	2554-1		200.7+AA furnace	<0.01	3.5	3.5	10	3.5	13	95
As	"	"		"	<0.01	0.03	0.05	0.1	0.04	0.13	90
Ba	"	"		"	<0.05	0.07	0.07	1.0	0.07	1.04	97
Be	"	"		"	<0.01	<0.01	<0.01	0.1	<0.01	0.1	100
B	"	"		"	<0.05	0.4	0.4	1.0	0.4	1.2	80
Cd	"	"		"	<0.01	<0.01	<0.01	0.1	<0.01	0.08	80
Ca	"	"		"	0.07	430	400	100	410	530	120
Cr	"	"		"	<0.05	<0.05	<0.05	0.5	<0.05	0.42	84
Cu	"	"		"	<0.05	<0.05	<0.05	0.5	<0.05	0.49	98
Fe	"	"		"	<0.05	22	25	10	23	35	120
Pb	"	"		"	<0.01	<0.01	<0.01	0.1	0.01	0.09	90
Mg	"	"		"	<0.05	160	160	1.0	160	0.93	93

* If % moisture is reported, results are presented on a dry-weight basis.

** F = Flame AAS

G = Graphite Furnace AAS

H = Hydride Vapor AAS

C = Cold Vapor AAS

P = Inductively Coupled Plasma

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2} \times 100$$

C1 = Concentration One
C2 = Concentration Two

$$\text{Percent Recovery (PR)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Sample Matrix:

✓ X/ Water (mg/L) (mg/l) Dilution Factor _____✓ / Soil (ug/g) (ug/Kg) *Moisture _____✓ / Other _____

Spike Source(s) _____

QC Report No. QCM20

Laboratory Supervisor Approval: _____

Analyte Metal	Laboratory Sample Nos.		Date Anal	**Anal Method	Blank	Duplicates			Spike Recovery			Notes	
	Duplicates	Spike				C1	C2	RPD	SA	SR	SSR		PR
Mn	2554-1	2554-1		200.7+AA Furnace	<0.05	0.07	0.07	0	1.0	0.07	1.1	110	
Mo	"	"		"	<0.01	<0.01	<0.01		0.1	<0.01	0.01	100	
Ni	"	"		"	<0.05	<0.05	<0.05		1.0	<0.05	0.97	97	
K	"	"		"	<1	37	45	17	10	41	52	110	
Se	"	"		"	<0.01	0.15	0.21	67**	0.1	0.18	0.26	80	
Si	"	"		"	<1	13	13	0	10	13	23	100	
Ag	"	"		"	<0.05	<0.05			0.1	<0.05	0.09	90	
Na	"	"		"	<1.0	1400	1400	0	1000	1400	2300	90	
Tl	"	"		"	<0.5	<0.5	<0.5		1	<0.5	1.1	110	

* If % moisture is reported, results are presented on a dry-weight basis.

** F = Flame AAS

G = Graphite Furnace AAS

H = Hydride Vapor AAS

C = Cold Vapor AAS

P = Inductively Coupled Plasma

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2} \times 100$$

$$\text{Percent Recovery (PR)} = \frac{SSR - SR}{SA} \times 100$$

SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Added (Concentration)

Engineering-Science

QUALITY CONTROL RESULTS SUMMARY

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Sample Matrix:

$\text{L}_x / \text{Water (ug/l.)}$

Dilution Factor

$$L / \text{Sol l (ug/g)} \text{ (ug/kg)}$$

• Holistic

for ~~other~~

Apple Source(s) EPA

QC Report No. QC PH1

Laboratory Supervisor Approval:

J. W. Anderson

[illegible]

* If a moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2}$$

$$\text{Percent Recovery (Pr)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

QUALITY CONTROL, RESULTS SUMMARY

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QC Report No. QC PH2

Dilution Factor

Outline

J. W. Andrews

EPA

[illegible]

* If moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2}$$

$$\text{Percent Recovery (PR)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

QUALITY CONTROL, RESULTS SUMMARY

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report

QC Report No. QC PH3

№	Вещество	Содержание, мг/г	Мол. вес
1	Вещество 1	100	100
2	Вещество 2	200	200
3	Вещество 3	300	300
4	Вещество 4	400	400
5	Вещество 5	500	500
6	Вещество 6	600	600
7	Вещество 7	700	700
8	Вещество 8	800	800
9	Вещество 9	900	900
10	Вещество 10	1000	1000

Laboratory Supervisor Approval:

R. W. Anderson

[illegible]

* If moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2}$$

$$\text{Percent Recovery (m)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

QUALITY CONTROL RESULTS SUMMARY

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QC Report No. QC PH4

Dilution Factor

Molature 48% Solids

J. W. Anderson

ETA

[illegible]

* If moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2}$$

C1 = Concentration One
C2 = Concentration Two

$$\text{Percent Recovery (PR)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

Engineering - Science

QUALITY CONTROL RESULTS SUMMARY

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Sample Matrix:

$$X/\text{Water (ug/l.)}$$

Dilution Factor

/ Sol 1 (ug/g) (ug/kg)

Moisture

Other /

QC Report No. QC PH5

Laboratory Supervisor Approval:

Spike Source(s) EPA

[illegible]

• If moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2}$$

$$\text{Percent Recovery (Pr)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

Lab Sample Nos.

QC Report No. QCH1Duplicates 2785-23Date Analyzed 11/22/86Spike 2785-23

Laboratory Supervisor Approval:

Sample Matrix: AAJ. W. G. G.
Dilution Factor 1/ Water (ug/L)*Moisture 92/X Soil (ug/g) (ug/Kg)/ Other Spike Source EPA

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
2,4-D	<0.03	<.03	<.03		0.2	<.03	0.21	105	108**
2,4-DB	<0.01	<.01	<.01		0.2	<.01	0.19	95	
2,4,5-T	<0.02	<.02	<.02		0.2	<.02	0.17	85	
2,4,5-TP Silvex	<0.003	<.003	<.003		0.2	<.003	0.17	85	84**
DICAMBA	<0.01	<.01	<.01		0.2	<.01	.16	80	
DICHLORPROP	<0.05	<.05	<.05		0.5	<.05	.43	86	
DINOSEB	<0.02	<.02	<.02		0.2	<.02	0.21	105	
(4-Chloro-2-Methylphenoxy) -Acetic Acid	8.0	<8	<8		50	<8	37	74	
2-(4-Chloro-2-Methylphenoxy) -Propanoic Acid	<11	<11	<11		50	<11	41	82	

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

** Recovery of second spike

859J111

QUALITY ASSURANCE/QUALITY CONTROL DATA

AUGUST 1987 SAMPLES

Lab Sample Nos.

Duplicates MS, MSPSpike Standards A + B

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. QC V-1Date Analyzed 8/25/87

Laboratory Supervisor Approval:

J. W. AndersonDilution Factor 1.0*Moisture NASpike Source Supelco Purgeables A + BSP-1000 column

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	ND								
Bromoform									
Bromomethane									
Carbon tetrachloride									
Chlorobenzene		9.4	8.5	10	10.0	ND	9.4	94	
Chloroethane									
2-Chloroethylvinyl ether									
Chloroform									
Chloromethane									
Dibromochloromethane									
1,2-Dichlorobenzene									
1,3-Dichlorobenzene									
1,4-Dichlorobenzene									
Dichlorodifluoromethane									
1,1-Dichloroethane									
1,2-Dichloroethane									
1,1-Dichloroethene		9.9	7.4	28.9	10.0	ND	9.9	99	
trans-1,2-Dichloroethene									
1,2-Dichloropropane									
cis-1,3-Dichloropropene									
trans-1,3-Dichloropropene									
Methylene chloride									
1,1,2,2-Tetrachloroethane									
Tetrachloroethene									
1,1,1-Trichloroethane									
1,1,2-Trichloroethane									
Trichloroethene		9.8	8.7	11.9	10.0	ND	9.8	98	
Trichlorofluoromethane	↓								
Vinyl chloride	ND								

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$

SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Added (Concentration)

859J111

Lab Sample Nos.

Duplicates MS, MSDSpike Standards A+B

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. QCV-1Date Analyzed 8/25/87

Laboratory Supervisor Approval:

J. W. AndrewDilution Factor 1.0*Moisture NASpike Source Supelco Purgeables A+B

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	AD								
Bromoform									
Bromomethane									
Carbon tetrachloride									
Chlorobenzene					10.0	ND	8.5	85	
Chloroethane									
2-Chloroethylvinyl ether									
Chloroform									
Chloromethane									
Dibromochloromethane									
1,2-Dichlorobenzene									
1,3-Dichlorobenzene									
1,4-Dichlorobenzene									
Dichlorodifluoromethane									
1,1-Dichloroethane									
1,2-Dichloroethane									
1,1-Dichloroethene					10.0	ND	7.4	74	
trans-1,2-Dichloroethene									
1,2-Dichloropropane									
cis-1,3-Dichloropropene									
trans-1,3-Dichloropropene									
Methylene chloride									
1,1,2,2-Tetrachloroethane									
Tetrachloroethene									
1,1,1-Trichloroethane									
1,1,2-Trichloroethane									
Trichloroethene					10.0	ND	8.7	87	
Trichlorofluoromethane									
Vinyl chloride	ND								

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

859J111

I-81

Lab Sample Nos.

Duplicates MS, MSDSpike Purgeables A+B

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. QC V-1Date Analyzed 8/25/87

Laboratory Supervisor Approval:

J. W. AndersonDilution Factor 1.0*Moisture NASpike Source Supelco Purgeables A+B

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Benzene	ND	10.5	10.0	4.9	10.0	ND	10.5	105	
Chlorobenzene	↓								
1,2-Dichlorobenzene									
1,3-Dichlorobenzene									
1,4-Dichlorobenzene									
Ethylbenzene	↓								
Toluene	ND	10.8	10.3	4.7	10.0	ND	10.8	108	

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD)

$$= \frac{C1 - C2}{(C1 + C2)/2}$$

C1 = Concentration One

C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$

SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates MS, MSDSpike Purgeables A+B

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. QC V-1Date Analyzed 8/25/87

Laboratory Supervisor Approval:

J. W. AndersonDilution Factor 1.0*Moisture NA %Spike Source Supelco Purgeables A+B

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Benzene	ND				10.0	ND	10.0	100	
Chlorobenzene									
1,2-Dichlorobenzene									
1,3-Dichlorobenzene									
1,4-Dichlorobenzene	↓								
Ethylbenzene	ND								
Toluene					10.0	ND	10.3	103	

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Lab Sample Nos.

QC Report No. QCV-2Duplicates MS, MSDDate Analyzed 8/24/87Spike Purgeables A+B

Laboratory Supervisor Approval:

Sample Matrix:

☒ Water (ug/L)Dilution Factor 1.0☐ Soil (ug/g) (ug/Kg)*Moisture NA☐ Other _____Spike Source Supelco A Standards A+BSP-1000 column

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	ND								
Bromoform									
Bromomethane									
Carbon tetrachloride									
Chlorobenzene		8.4	10.1	18.4	10.0	ND	8.4	84	
Chloroethane									
2-Chloroethylvinyl ether									
Chloroform									
Chloromethane									
Dibromochloromethane									
1,2-Dichlorobenzene									
1,3-Dichlorobenzene									
1,4-Dichlorobenzene									
Dichlorodifluoromethane									
1,1-Dichloroethane									
1,2-Dichloroethane									
1,1-Dichloroethene		10.1	11.1	9.4	10.0	ND	10.1	101	
trans-1,2-Dichloroethene									
1,2-Dichloropropane									
cis-1,3-Dichloropropene									
trans-1,3-Dichloropropene									
Methylene chloride									
1,1,2,2-Tetrachloroethane									
Tetrachloroethene									
1,1,1-Trichloroethane									
1,1,2-Trichloroethane									
Trichloroethene		10.4	9.3	11.2	10.0	ND	10.4	104	
Trichlorofluoromethane									
Vinyl chloride	ND								

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD)

$$= \frac{C1 - C2}{(C1 + C2)/2}$$

C1 = Concentration One

C2 = Concentration Two

Percent Recovery (PR) =

$$\frac{SSR - SR}{SA} \times 100$$

SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates MS, MSDSpike Purgeables A+B

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. QGV-2Date Analyzed 8/24/87

Laboratory Supervisor Approval:

J. W. AllenDilution Factor 1.0*Moisture NASpike Source Supelco Purgeables A+B

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	ND								
Bromoform									
Bromomethane									
Carbon tetrachloride									
Chlorobenzene					10.0	ND	10.1	101	
Chloroethane									
2-Chloroethylvinyl ether									
Chloroform									
Chloromethane									
Dibromochloromethane									
1,2-Dichlorobenzene									
1,3-Dichlorobenzene									
1,4-Dichlorobenzene									
Dichlorodifluoromethane									
1,1-Dichloroethane									
1,2-Dichloroethane									
1,1-Dichloroethene					10.0	ND	11.1	111	
trans-1,2-Dichloroethene									
1,2-Dichloropropane									
cis-1,3-Dichloropropene									
trans-1,3-Dichloropropene									
Methylene chloride									
1,1,2,2-Tetrachloroethane									
Tetrachloroethene									
1,1,1-Trichloroethane									
1,1,2-Trichloroethane									
Trichloroethene					10.0	ND	9.3	93	
Trichlorofluoromethane	✓								
Vinyl chloride	ND								

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD)

$$= \frac{C1 - C2}{(C1 + C2)/2}$$

C1 = Concentration One

C2 = Concentration Two

Percent Recovery (PR) =

$$\frac{SSR - SR}{SA} \times 100$$

SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates MS, MSDSpike Purgeables A+B

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. QCV-2Date Analyzed 8/24/87

Laboratory Supervisor Approval:

J. W. O'BrienDilution Factor 1.0*Moisture N/ASpike Source Supelco Purgeables A+B

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Benzene	ND	10.3	9.2	11.3	10.0	ND	10.3	103	
Chlorobenzene	↓								
1,2-Dichlorobenzene									
1,3-Dichlorobenzene									
1,4-Dichlorobenzene									
Ethylbenzene	↓								
Toluene	ND	9.8	9.2	6.3	10.0	ND	9.8	98	

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD)

$$= \frac{C1 - C2}{(C1 + C2)/2}$$

C1 = Concentration One

C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$

SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates MS, MSDSpike Purgeables A+B

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. DCV-2Date Analyzed 8/24/87

Laboratory Supervisor Approval:

J. W. AdamsDilution Factor 1.0

*Moisture

NASpike Source Supelco Purgeables A+B

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Benzene	ND				10.0	ND	9.2	92	
Chlorobenzene									
1,2-Dichlorobenzene									
1,3-Dichlorobenzene									
1,4-Dichlorobenzene									
Ethylbenzene	↓								
Toluene	ND				10.0	ND	9.2	92	

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD)

$$= \frac{C1 - C2}{(C1 + C2)/2}$$

C1 = Concentration One

C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$

SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Added (Concentration)

Purgeable Halocarbons

EPA Method 601

Lab Sample Nos.

Duplicates MS, MSDSpike Purgeables Std A+B

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. QCV P-1Date Analyzed 8/27/87

Laboratory Supervisor Approval:

J. W. ArdenDilution Factor 1.0*Moisture NASpike Source Supelco Purgeables A+BPoracil C column

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	ND								
Bromoform									
Bromomethane									
Carbon tetrachloride									
Chlorobenzene		9.4	9.4	0	10.0	ND	9.4	94	
Chloroethane									
2-Chloroethylvinyl ether									
Chloroform		10.4	10.1	2.9	10.0	ND	10.4	104	
Chloromethane									
Dibromochloromethane									
1,2-Dichlorobenzene									
1,3-Dichlorobenzene									
1,4-Dichlorobenzene									
Dichlorodifluoromethane									
1,1-Dichloroethane									
1,2-Dichloroethane									
1,1-Dichloroethene		10.1	10.2	0.98	10.0	ND	10.1	101	
trans-1,2-Dichloroethene									
1,2-Dichloropropane									
cis-1,3-Dichloropropene									
trans-1,3-Dichloropropene									
Methylene chloride		8.3	8.4	1.2	10.0	ND	8.3	83	
1,1,2,2-Tetrachloroethane									
Tetrachloroethene									
1,1,1-Trichloroethane									
1,1,2-Trichloroethane									
Trichloroethene									
Trichlorofluoromethane	✓								
Vinyl chloride	ND								

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates MS, MSDSpike Purgeable Stds A+B

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. Q CVP-1

Date Analyzed _____

Laboratory Supervisor Approval:

J. W. AdamsDilution Factor 1.0*Moisture NASpike Source Supelco Purgeables Stds A+B

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	ND								
Bromoform									
Bromomethane									
Carbon tetrachloride									
Chlorobenzene					10.0	ND	9.4	94	
Chloroethane									
2-Chloroethylvinyl ether									
Chloroform					10.0	ND	10.1	101	
Chloromethane									
Dibromochloromethane									
1,2-Dichlorobenzene									
1,3-Dichlorobenzene									
1,4-Dichlorobenzene									
Dichlorodifluoromethane									
1,1-Dichloroethane									
1,2-Dichloroethane									
1,1-Dichloroethene					10.0	ND	10.2	102	
trans-1,2-Dichloroethene									
1,2-Dichloropropane									
cis-1,3-Dichloropropene									
trans-1,3-Dichloropropene									
Methylene chloride					10.0	ND	8.4	84	
1,1,2,2-Tetrachloroethane									
Tetrachloroethene									
1,1,1-Trichloroethane									
1,1,2-Trichloroethane									
Trichloroethene									
Trichlorofluoromethane	↓								
Vinyl chloride	ND								

* If % moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2} \quad \begin{array}{l} C1 = \text{Concentration One} \\ C2 = \text{Concentration Two} \end{array}$$

$$\text{Percent Recovery (PR)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates MS, MSDSpike Purgeables A + B

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. QCVP-2Date Analyzed 8/29/87

Laboratory Supervisor Approval:

Dilution Factor 1.0*Moisture NASpike Source Supelco Stds A + BPoracil C column

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	ND								
Bromoform									
Bromomethane									
Carbon tetrachloride									
Chlorobenzene		10.8	10.9	0.92	10.0	ND	10.8	108	
Chloroethane									
2-Chloroethylvinyl ether									
Chloroform		7.9	8.2	3.7	10.0	ND	7.9	79	
Chloromethane									
Dibromochloromethane									
1,2-Dichlorobenzene									
1,3-Dichlorobenzene									
1,4-Dichlorobenzene									
Dichlorodifluoromethane									
1,1-Dichloroethane									
1,2-Dichloroethane									
1,1-Dichloroethene		9.0	8.6	4.5	10.0	ND	9.0	90	
trans-1,2-Dichloroethene									
1,2-Dichloropropane									
cis-1,3-Dichloropropene									
trans-1,3-Dichloropropene									
Methylene chloride		8.1	9.2	12.7	10.0	ND	8.1	81	
1,1,2,2-Tetrachloroethane									
Tetrachloroethene									
1,1,1-Trichloroethane									
1,1,2-Trichloroethane									
Trichloroethene									
Trichlorofluoromethane	↓								
Vinyl chloride	ND								

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD) = $\frac{C1 - C2}{(C1 + C2)/2}$ C1 = Concentration One
C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$ SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

Lab Sample Nos.

QC Report No. QCV-2Duplicates MS, MSD

Date Analyzed _____

Spike Purgeables A+B

Laboratory Supervisor Approval: _____

Sample Matrix:

☒ Water (ug/L)Dilution Factor 1.0☐ Soil (ug/g) (ug/Kg)*Moisture NA☐ Other _____Spike Source Supelco Purgeables Standards A+B Poracil Column

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Bromodichloromethane	ND								
Bromoform									
Bromomethane									
Carbon tetrachloride									
Chlorobenzene					10.0	ND	10.9	109	
Chloroethane									
2-Chloroethylvinyl ether									
Chloroform					10.0	ND	8.2	82	
Chloromethane									
Dibromochloromethane									
1,2-Dichlorobenzene									
1,3-Dichlorobenzene									
1,4-Dichlorobenzene									
Dichlorodifluoromethane									
1,1-Dichloroethane									
1,2-Dichloroethane									
1,1-Dichloroethene					10.0	ND	8.6	86	
trans-1,2-Dichloroethene									
1,2-Dichloropropane									
cis-1,3-Dichloropropene									
trans-1,3-Dichloropropene									
Methylene chloride					10.0	ND	9.2	92	
1,1,2,2-Tetrachloroethane									
Tetrachloroethene									
1,1,1-Trichloroethane									
1,1,2-Trichloroethane									
Trichloroethene									
Trichlorofluoromethane	ND								
Vinyl chloride	ND								

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD)

$$= \frac{C1 - C2}{(C1 + C2)/2}$$

C1 = Concentration One

C2 = Concentration Two

Percent Recovery (PR) =

$$\frac{SSR - SR}{SA} \times 100$$

SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates MS, MSDSpike Supelco A, B

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other _____QC Report No. QCUB-1Date Analyzed 8.27.87

Laboratory Supervisor Approval:

J. W. OrdmanDilution Factor 1.0

*Moisture _____ %

Spike Source Supelco Std A + B Bentone 34 column

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Benzene	ND	5.1	5.6	9.3	10.0	ND	5.1	51	
Chlorobenzene		5.7	6.2	8.4	10.0	ND	5.7	57	
1,2-Dichlorobenzene									
1,3-Dichlorobenzene									
1,4-Dichlorobenzene									
Ethylbenzene	↓	6.2	5.7	8.4	10.0	ND	6.2	62	
Toluene	ND	5.5	5.9	7.0	10.0	ND	5.5	55	

* If % moisture is reported, results are presented on a dry-weight basis.

Relative Percent Difference (RPD)

$$= \frac{C1 - C2}{(C1 + C2)/2}$$

C1 = Concentration One

C2 = Concentration Two

Percent Recovery (PR) = $\frac{SSR - SR}{SA} \times 100$

SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Added (Concentration)

Lab Sample Nos.

Duplicates MS, MSDSpike Supelco A+B

Sample Matrix:

☒ Water (ug/L)☐ Soil (ug/g) (ug/Kg)☐ Other QC Report No. QCVB-1Date Analyzed 8/22/87

Laboratory Supervisor Approval:

J. V. AndersonDilution Factor 1.0*Moisture NASpike Source Supelco Purgeables A+B

Compound	Blank	Duplicates			Spike Recovery				Notes
		C1	C2	RPD	SA	SR	SSR	PR	
Benzene	ND				10.0	ND	5.6	56	
Chlorobenzene	↓				10.0	ND	5.7	57	
1,2-Dichlorobenzene									
1,3-Dichlorobenzene									
1,4-Dichlorobenzene	↓								
Ethylbenzene	ND				10.0	ND	5.7	57	
Toluene					10.0	ND	5.9	59	

* If % moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2} \quad \begin{array}{l} C1 = \text{Concentration One} \\ C2 = \text{Concentration Two} \end{array}$$

$$\text{Percent Recovery (PR)} = \frac{SSR - SR}{SA} \times 100$$

SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added (Concentration)

QUALITY CONTROL RESULTS SUMMARY

Page 1 of 2
Report

QC Report No. QC 625-1

Laboratory Supervisor Approval:

J. W. Andrews

Spike Source(s) EPA Repository Triangle Park, NC

[illegible]

* If % moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C_1 - C_2}{(C_1 + C_2)/2}$$

$$\text{Percent Recovery (PR)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

QUALITY CONTROL RESULTS SUMMARY

Page 2 of
ReportQC Report No. QC 625-1

Laboratory Supervisor Approval:

J. W. Andrews

[illegible]

* If moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C_1 - C_2}{(C_1 + C_2)/2}$$

$$\text{Percent Recovery (PR)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

QUALITY CONTROL RESULTS SUMMARY

Sample Matrix:

Sample Matrix:	Water (ug/L)	Soil (ug/g)	(ug/Kg)
<u>XX</u>			
/			

Dilution Factor 1.0

*Moisture	NA
100	100
90	90
80	80
70	70
60	60
50	50
40	40
30	30
20	20
10	10
0	0

/ / Other

Spike	Source(s)	EPA Repository	Triangle Park, NC
1
2
3
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99
100

QC Report No. QC 625-1

Laboratory Supervisor Approval:

J. W. Andrew

[illegible]

* If mbisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2}$$

$$\text{Percent Recovery (PR)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

Sample Matrix:

/X/ Water (ug/L)

Dilution Factor 1.0

/ / Soil (ug/g) (ug/kg)

*Moisture	NA
100	100
90	90
80	80
70	70
60	60
50	50
40	40
30	30
20	20
10	10
0	0

/ / Other

Spike Source(s) EPA Repository Triangle Park, NC

QC Report No.

Laboratory Supervisor Approval:

J. W. Andrew

[illegible]

* If % moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2}$$

$$\text{Percent Recovery (PR)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

Sample Matrix:

	Water (ug/L)	Dilution Factor
1	100	10
2	100	10
3	100	10
4	100	10
5	100	10
6	100	10
7	100	10
8	100	10
9	100	10
10	100	10
11	100	10
12	100	10
13	100	10
14	100	10
15	100	10
16	100	10
17	100	10
18	100	10
19	100	10
20	100	10
21	100	10
22	100	10
23	100	10
24	100	10
25	100	10
26	100	10
27	100	10
28	100	10
29	100	10
30	100	10
31	100	10
32	100	10
33	100	10
34	100	10
35	100	10
36	100	10
37	100	10
38	100	10
39	100	10
40	100	10
41	100	10
42	100	10
43	100	10
44	100	10
45	100	10
46	100	10
47	100	10
48	100	10
49	100	10
50	100	10
51	100	10
52	100	10
53	100	10
54	100	10
55	100	10
56	100	10
57	100	10
58	100	10
59	100	10
60	100	10
61	100	10
62	100	10
63	100	10
64	100	10
65	100	10
66	100	10
67	100	10
68	100	10
69	100	10
70	100	10
71	100	10
72	100	10
73	100	10
74	100	10
75	100	10
76	100	10
77	100	10
78	100	10
79	100	10
80	100	10
81	100	10
82	100	10
83	100	10
84	100	10
85	100	10
86	100	10
87	100	10
88	100	10
89	100	10
90	100	10
91	100	10
92	100	10
93	100	10
94	100	10
95	100	10
96	100	10
97	100	10
98	100	10
99	100	10
100	100	10

	Soil (ug/g) (ug/Kg)	*Moisture	N _L	%
/	/			

/ / Other

Spike Source(s) EPA Repository Triangle Park, NC

QC Report No. QC 625-2

Laboratory Supervisor Approval:

J. W. Andrews

[illegible]

* If moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2}$$

$$\text{Percent Recovery (PR)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

SSR = Spiked Sample Result:

SR = Sample Result

Spike Added (Concentration)

QUALITY CONTROL RESULTS SUMMARY

Page 2 of 2
Report

Dilution Factor 1.0

Moisture	NA	g
0.00	0.00	0.00
0.01	0.01	0.01
0.02	0.02	0.02
0.03	0.03	0.03
0.04	0.04	0.04
0.05	0.05	0.05
0.06	0.06	0.06
0.07	0.07	0.07
0.08	0.08	0.08
0.09	0.09	0.09
0.10	0.10	0.10
0.11	0.11	0.11
0.12	0.12	0.12
0.13	0.13	0.13
0.14	0.14	0.14
0.15	0.15	0.15
0.16	0.16	0.16
0.17	0.17	0.17
0.18	0.18	0.18
0.19	0.19	0.19
0.20	0.20	0.20
0.21	0.21	0.21
0.22	0.22	0.22
0.23	0.23	0.23
0.24	0.24	0.24
0.25	0.25	0.25
0.26	0.26	0.26
0.27	0.27	0.27
0.28	0.28	0.28
0.29	0.29	0.29
0.30	0.30	0.30
0.31	0.31	0.31
0.32	0.32	0.32
0.33	0.33	0.33
0.34	0.34	0.34
0.35	0.35	0.35
0.36	0.36	0.36
0.37	0.37	0.37
0.38	0.38	0.38
0.39	0.39	0.39
0.40	0.40	0.40
0.41	0.41	0.41
0.42	0.42	0.42
0.43	0.43	0.43
0.44	0.44	0.44
0.45	0.45	0.45
0.46	0.46	0.46
0.47	0.47	0.47
0.48	0.48	0.48
0.49	0.49	0.49
0.50	0.50	0.50
0.51	0.51	0.51
0.52	0.52	0.52
0.53	0.53	0.53
0.54	0.54	0.54
0.55	0.55	0.55
0.56	0.56	0.56
0.57	0.57	0.57
0.58	0.58	0.58
0.59	0.59	0.59
0.60	0.60	0.60
0.61	0.61	0.61
0.62	0.62	0.62
0.63	0.63	0.63
0.64	0.64	0.64
0.65	0.65	0.65
0.66	0.66	0.66
0.67	0.67	0.67
0.68	0.68	0.68
0.69	0.69	0.69
0.70	0.70	0.70
0.71	0.71	0.71
0.72	0.72	0.72
0.73	0.73	0.73
0.74	0.74	0.74
0.75	0.75	0.75
0.76	0.76	0.76
0.77	0.77	0.77
0.78	0.78	0.78
0.79	0.79	0.79
0.80	0.80	0.80
0.81	0.81	0.81
0.82	0.82	0.82
0.83	0.83	0.83
0.84	0.84	0.84
0.85	0.85	0.85
0.86	0.86	0.86
0.87	0.87	0.87
0.88	0.88	0.88
0.89	0.89	0.89
0.90	0.90	0.90
0.91	0.91	0.91
0.92	0.92	0.92
0.93	0.93	0.93
0.94	0.94	0.94
0.95	0.95	0.95
0.96	0.96	0.96
0.97	0.97	0.97
0.98	0.98	0.98
0.99	0.99	0.99
1.00	1.00	1.00

/ / Other

Spike Source(s) EPA Repository Triangle Park, NC

Laboratory Supervisor Approval:

J. W. Chubb

[illegible]

• If moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2}$$

$$\text{Percent Recovery (PR)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

Sample Matrix:

QC Report No. QC 625-2

/X/ Water (ug/l.)

Dilution Factor 1.0

/ / Soil (ug/g) (ug/kg)

Moisture	NA
0.00	0.00
0.01	0.01
0.02	0.02
0.03	0.03
0.04	0.04
0.05	0.05
0.06	0.06
0.07	0.07
0.08	0.08
0.09	0.09
0.10	0.10
0.11	0.11
0.12	0.12
0.13	0.13
0.14	0.14
0.15	0.15
0.16	0.16
0.17	0.17
0.18	0.18
0.19	0.19
0.20	0.20
0.21	0.21
0.22	0.22
0.23	0.23
0.24	0.24
0.25	0.25
0.26	0.26
0.27	0.27
0.28	0.28
0.29	0.29
0.30	0.30
0.31	0.31
0.32	0.32
0.33	0.33
0.34	0.34
0.35	0.35
0.36	0.36
0.37	0.37
0.38	0.38
0.39	0.39
0.40	0.40
0.41	0.41
0.42	0.42
0.43	0.43
0.44	0.44
0.45	0.45
0.46	0.46
0.47	0.47
0.48	0.48
0.49	0.49
0.50	0.50
0.51	0.51
0.52	0.52
0.53	0.53
0.54	0.54
0.55	0.55
0.56	0.56
0.57	0.57
0.58	0.58
0.59	0.59
0.60	0.60
0.61	0.61
0.62	0.62
0.63	0.63
0.64	0.64
0.65	0.65
0.66	0.66
0.67	0.67
0.68	0.68
0.69	0.69
0.70	0.70
0.71	0.71
0.72	0.72
0.73	0.73
0.74	0.74
0.75	0.75
0.76	0.76
0.77	0.77
0.78	0.78
0.79	0.79
0.80	0.80
0.81	0.81
0.82	0.82
0.83	0.83
0.84	0.84
0.85	0.85
0.86	0.86
0.87	0.87
0.88	0.88
0.89	0.89
0.90	0.90
0.91	0.91
0.92	0.92
0.93	0.93
0.94	0.94
0.95	0.95
0.96	0.96
0.97	0.97
0.98	0.98
0.99	0.99
1.00	1.00

/ / Other

J. W. Andrew

Spike Source(s) EPA Repostory, Triangle Park, NC

[illegible]

* If moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2}$$

$$\text{Percent Recovery (PR)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

QUALITY CONTROL RESULTS SUMMARY

Page 2 of 2
Report

QC Report No. QC625-2

Laboratory Supervisor Approval:

Spike Source(s) EPA Repository Triangle Park, NC

[illegible]

* If moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2}$$

$$\text{Percent Recovery (Pr)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

QUALITY CONTROL RESULTS SUMMARY

Sample Matrix:

QC Report No. HC-IRQ-1

/ X / water (ug/l.)

Dilution Factor 1.0

/ / Soil (µg/g) (µg/kg)

Moisture

2A

/ / other

Spike Source(s)	Petroleum (motor) oil
1	
2	
3	
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99	
100	

[illegible]

* If % moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2}$$

$$\text{Percent Recovery (PR)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

QUALITY CONTROL RESULTS SUMMARY

Page 1 of 1
Report 2430

QC Report No. QC-Pb-1

Dilution Factor 1.0

Moisture N/A

Spike Source(s) Baker Inspg - Analyzed # 6930-1

[illegible]

* If moisture is reported, results are presented on a dry-weight basis.

$$\text{Relative Percent Difference (RPD)} = \frac{C1 - C2}{(C1 + C2)/2}$$

C1 = Concentration One
C2 = Concentration Two

$$\text{Percent Recovery (PR)} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

DECONTAMINATION WATER ANALYSIS

ENGINEERING SCIENCE
Priority Pollutant Analysis
Base Neutrals - EPA 625
Matrix: Water

page 1 of 4

Date Received: N/A
Date Reported: August 15, 1987

P.O. No.: 1111111111
Job No.: AT001

FOR: ES:Atlanta
Address: 57 Executive Park South, N.E., Suite 590
Atlanta, Georgia 30329
ATTN: Ms. Sharon Schultz

Lab Number: Purified
Sample No.: Water
Date Sampled: N/A
Time Sampled: N/A
Date Extracted: 8-4-87
Date Analyzed: 8-6-87

Compound	Detection Limits ug/L	ANALYTICAL RESULTS	
		ug/L	
1,3-Dichlorobenzene	2	ND	
1,4-Dichlorobenzene	2	ND	
Hexachloroethane	2	ND	
Bis(2-chloroethyl)ether	6	ND	
1,2-Dichlorobenzene	2	ND	
N-Nitrosodimethylamine	25	ND	
Bis(2-chloroisopropyl)ether	6	ND	
N-Nitrosodi-n-propyl amine	25	ND	
Hexachlorobutadiene	1	ND	
1,2,4-Trichlorobenzene	2	ND	
Nitrobenzene	2	ND	
Isophorone	2	ND	
Naphthalene	2	ND	
Bis(2-chloroethoxy)methane	5	ND	
2-Chloronaphthalene	2	ND	
Hexachlorocyclopentadiene	25	ND	
Acenaphthylene	4	ND	
Acenaphthene	2	ND	
Dimethyl phthalate	2	ND	
2,6-Dinitrotoluene	2	ND	
Fluorene	2	ND	
2,4-Dinitrotoluene	2	ND	
Diethyl phthalate	2	ND	
N-Nitrosodiphenylamine	2	ND	
Hexachlorobenzene	2	ND	

Priority Pollutant Analysis
Base Neutrals - EPA 625
Matrix: Water
(continued)

page 2 of 4

Date Received: N/A
Date Reported: August 15, 1987

P.O. No.: 11111
Job No.: AT001

FOR: ES:Atlanta
Address: 57 Executive Park South, N.E., Suite 590
Atlanta, Georgia 30329
ATTN: Ms. Sharon Schultz

Lab Number: Purified
Sample No.: Water
Date Sampled: N/A
Time Sampled: N/A
Date Extracted: 8-4-87
Date Analyzed: 8-6-87

Compound	Detection Limit ug/L	ANALYTICAL RESULTS ug/L
Phenanthrene	5	ND
Anthracene	2	ND
Dibutyl phthalate	3	ND
Fluoranthene	2	ND
4-Chlorophenyl phenyl ether	4	ND
Pyrene	2	ND
Butyl Benzyl phthalate	3	ND
Bis(2-ethylhexyl) phthalate	3	ND
Chrysene	3	ND
4-Bromophenyl phenyl ether	2	ND
Benzo(a)anthracene	8	ND
Di-n-octylphthalate	3	ND
Benzo(b)fluoranthene	5	ND
Benzo(k)fluoranthene	3	ND
Benzidine	60	ND
3,3'-Dichlorobenzidine	40	ND
Benzo(a)pyrene	3	ND
Indeno(1,2,3-cd)pyrene	4	ND
Dibenzo(a,h)anthracene	3	ND
Benzo(ghi)perylene	4	ND

Date Received: N/A
Date Reported: August 15, 1987

P.O. No. :
Job No : AT001

FOR: ES:Atlanta
Address: 57 Executive Park South, N.E., Suite 590
Atlanta, Georgia 30329
ATTN: Ms. Sharon Schultz

Lab Number: Purified
Sample No.: Water
Date Sampled: N/A
Time Sampled: N/A
Date Extracted: 8-4-87
Date Analyzed: 8-6-87

Compound	Detection	ANALYTICAL RESULTS
	Limits	
	ug/L	ug/L
Alpha-BHC	--*	ND
Gamma-BHC	—*	ND
Beta-BHC	4	ND
Heptachlor	2	ND
Delta-BHC	3	ND
Aldrin	2	ND
Heptachlor epoxide	2	ND
Endosulfan I	--*	ND
Dieldrin	3	ND
4,4'-DDE	6	ND
Endrin	--*	ND
Endosulfan II	--*	ND
4,4'-DDD	3	ND
4,4'-DDT	5	ND
Endosulfan Sulfate	6	ND
Endrin aldehyde	--*	ND
Chlordane	40	ND
Toxaphene	40	ND
PCB-1016	40	ND
PCB-1221	40	ND
PCB-1232	40	ND
PCB-1242	40	ND
PCB-1248	40	ND
PCB-1254	40	ND
PCB-1260	40	ND

* Detection Limits have not yet been determined for these compounds

Priority Pollutant Analysis
Acid Extractables -- EPA 625
Matrix: Water

page 4 of 4

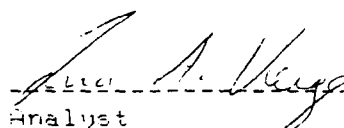
Date Received: N/A
Date Reported: August 15, 1987

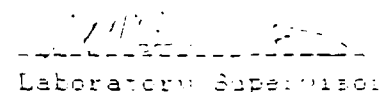
P.O. No.: 1111-1111
Job No.: AT001

FOR: ES:Atlanta
Address: 57 Executive Park South, N.E., Suite 590
Atlanta, Georgia 30329
ATTN: Ms. Sharon Schultz

Lab Number: Purified
Sample No.: Water
Date Sampled: N/A
Time Sampled: N/A
Date Extracted: 8-4-87
Date Analyzed: 8-6-87

Compound	Detection	ANALYTICAL RESULTS	
	Limits ug/L	ug/L	
1-Chlorophenol	3	ND	
2-Nitrophenol	4	ND	
Phenol	2	ND	
2,4-Dimethylphenol	3	ND	
2,4-Dichlorophenol	3	ND	
2,4,6-Trichlorophenol	3	ND	
4-Chloro-3-methylphenol	3	ND	
2,4-Dinitrophenol	40	ND	
2-Methyl-4,6-Dinitrophenol	20	ND	
Pentachlorophenol	4	ND	
4-Nitrophenol	3	ND	


Analyst


Laboratory Supervisor

NOTE: Samples are discarded 30 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.

Engineering-Science

ANALYTICAL RESULTS SUMMARY
Purgeable Aromatics
EPA Method 602

ES Job No.:	AT001	Lab Sample No.:	--
Client:	ES Atlanta	Field Sample No.:	ASTM Water lots 806, 813, 820
Attention:	Sharon Schultz	Date Collected:	N/A
Address:	57 Executive Park South, N.E., Suite 590 Atlanta, Georgia 30329	Time Collected:	N/A
		Date Received:	N/A
Project:	MacDill AFB	Date Analyzed:	8/06, 8/13, 8/21/87
		Date Reported:	8/31/87
		QC Report No.:	P111

Laboratory Supervisor Approval:

Sample Matrix:

/X/ Water (ug/L)
/ / Soil (ug/Kg)
/ / Other

Dilution Factor: N/A
*Moisture: N/A

Compound	Detection Limit	Analytical Results	Retention Time	
			Column 1	Column 2
Benzene	0.2	ND**		
Chlorobenzene	0.2	ND		
1,2-Dichlorobenzene	0.4	ND		
1,3-Dichlorobenzene	0.4	ND		
1,4-Dichlorobenzene	0.3	ND		
Ethylbenzene	0.2	ND		
Toluene	0.2	ND		

Surrogate Recovery 100%

* If % moisture is reported, results are presented on a dry-weight basis.
** ND = Not detectable at instrumental detection limits. Aqueous standards were used to determine detection limits.

155.6.1

Engineering-Science

ANALYTICAL RESULTS SUMMARY
Aromatic Volatile Organics
EPA Method 8020

Page 1 of 1

ES Job No.: AT001
Client: ES Atlanta
Attention: Sharon Schultz
Address: 57 Executive Park South,
N.E., Suite 590
Atlanta, Georgia 30329
Project: MacDill AFB
Laboratory Supervisor Approval:

Lab Sample No.: --
Field Sample No.: ASTM Water lots 806, 813, 82
Date Collected: N/A
Time Collected: N/A
Date Received: N/A
Date Analyzed: 8/06, 8/13, 8/21/87
Date Reported: 8/31/87
QC Report No.: P111

Sample Matrix:

(X) Water (ug/L) Dilution Factor: N/A
() Soil (ug/Kg) * Moisture (%): N/A
() Other

Compound	Detection Limit	Analytical Results	Retention Time	
			Column 1	Column 2
Benzene	0.2	ND**		
Chlorobenzene	0.2	ND		
1,2-Dichlorobenzene	0.4	ND		
1,3-Dichlorobenzene	0.4	ND		
1,4-Dichlorobenzene	0.3	ND		
Ethylbenzene	0.2	ND		
Toluene	0.2	ND		
Xylenes (Dimethyl benzene)	0.4	ND		

Surrogate Recovery 100%

- * If % moisture is reported, results are presented on a dry-weight basis.
** ND = Not detectable at instrumental detection limits. Aqueous standards were used to determine detection limits.

155.7.1

Engineering-Science

ANALYTICAL RESULTS SUMMARY

Purgeable Halocarbons

EPA Method 601

ES Job No.:	AT001	Lab Sample No.:	--
Client:	ES Atlanta	Field Sample No.:	ASTM Water lots 806, 813, 820
Attention:	Sharon Schultz	Date Collected:	N/A
Address:	57 Executive Park South,	Time Collected:	N/A
	N.E., Suite 590	Date Received:	N/A
	Atlanta, Georgia 30329	Date Analyzed:	8/06, 8/13, 8/21/87
Project:	MacDill AFB	Date Reported:	8/31/87
		QC Report No.:	P111

Laboratory Supervisor Approval:

Sample Matrix:

/X/ Water (ug/L)
 / / Soil (ug/kg)
 / / Other

Dilution Factor: N/A
 *Moisture: N/A

Compound	Detection Limit	Analytical Results	Retention Time	
			Column 1	Column 2
Bromodichloromethane	0.1	ND**		
Bromoform	0.2	ND		
Bromomethane	1.2	ND		
Carbon tetrachloride	0.12	ND		
Chlorobenzene	0.25	ND		
Chloroethane	0.52	ND		
2-Chloroethyl vinyl ether	0.13	ND		
Chloroform	0.05	ND		
Chloromethane	0.08	ND		
Dibromochloromethane	0.09	ND		
1,2-Dichlorobenzene	0.15	ND		
1,3-Dichlorobenzene	0.32	ND		
1,4-Dichlorobenzene	0.24	ND		
Dichlorodifluoromethane	1.8	ND		
1,1-Dichloroethane	0.13	ND		
1,2-Dichloroethane	0.03	ND		
1,1-Dichloroethene	0.13	ND		
trans-1,2-Dichloroethene	0.1	ND		
1,2-Dichloropropane	0.04	ND		
cis-1,3-Dichloropropene	0.2	ND		
trans-1,3-Dichloropropene	0.34	ND		
Methylene chloride	0.25	ND		
1,1,2,2-Tetrachloroethane	0.03	ND		
Tetrachloroethene	0.03	ND		
1,1,1-Trichloroethane	0.03	ND		
1,1,2-Trichloroethane	0.02	ND		
Trichloroethene	0.12	ND		
Trichlorofluoromethane	0.2	ND		
Vinyl chloride	0.18	ND		

Surrogate Recovery 100%

* If % moisture is reported, results are presented on a dry-weight basis.
 ** ND = Not detectable at instrumental detection limits. Aqueous standards were used to determine detection limits.